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DICTIONARY OF TECHNICAL TERMS FOR AEROSPACE USE

FIRST EDITION

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FOREWORD

IN TIME of rapid change, few things change more rapidly than language itself. Newly discovered phenomena, technologies that until lately have not even existed—each of these demands marked growth in the little conceptual handles that we call words, and that we use as tools to communicate and to record.

Sometimes this growth takes the form of new meanings added precariously to the top of loads carried by existing words, thus setting traps of incomprehension for the unwary. Sometimes the expansion takes the form of the creation, and spreading acceptance, of either freshly minted words or words previously recognized only by small coteries of specialists. The growth of language is a process that races past generally unperceived by most of us. Yet today surely millions of people must have at least a nodding acquaintance with words and terms that, a few years ago, would have quite baffled them in their current contexts, *e.g.*, *ablation*, *staging*, *midcourse correction*, and *hold*, to cite only a few. At times we are afforded a momentary glimpse of the phenomenon of language change: today we use the word *astronaut* with casual ease, but only a few years ago as it first crept into the language it sounded bizarre and even pretentious to many ears.

This volume attempts to define the meanings of selected terms in use in areas of activity of the National Aeronautics and Space Administration. The effort has been undertaken because exactness and precision are naturally most lacking in times of rapid language growth; and yet for scientists and engineers precision of meaning can have exceptional, even crucial, importance, as indeed it also can for contracting officers and management in general. But in one sense this book is almost certain to be imperfect. No set of definitions frozen in type can hope to capture the continuing change of living language. Readers of this first edition are cordially invited to submit suggested changes, corrections, refinements of definition, and exclusions to NASA (Headquarters Code ATS) with the thought that subsequent editions can better reflect the actual courses followed by the process of language growth.

MELVIN S. DAY, DIRECTOR
Scientific and Technical Information Division

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INTRODUCTION

THE *Dictionary of Technical Terms for Aerospace Use* is intended to ease the problem of communication among the various disciplines concerned by providing authoritative definitions of terms commonly used in the literature of space exploration. It is designed for use by a person with a scientific or engineering education who is writing or reading in a field outside his own specialty. It is expected that a person working in his own specialty will use the established references of that specialty which will usually define terms with more rigor and more detail than is possible in this Dictionary.

The definitions are intended to be accurate with respect to their technical content and to reflect the usage of experts in the various fields. The divergence in usage in different fields or within a given field sometimes requires that multiple definitions, which may be somewhat at variance with each other, be ascribed to a single term.

Each definition is intended to be as clear as possible to the non-expert, but accuracy has not been compromised for the sake of readability. Mathematics has been used where necessary to avoid ambiguity.

HISTORY

Work on the Dictionary was started in 1960 under the direction of B. A. Mulcahy, then Director of Technical Information of NASA, who had the responsibility of providing editorial standards for NASA technical publications. This Dictionary was planned to supplement the editorial standards issued by NASA Headquarters and the NASA Centers.

It was decided that this Dictionary would:

Coverage.

a) Cover both those fields concerned with the space environment, e.g., *geophysics* and *astronomy*, and those concerned with space operations, e.g., *rocketry* and *telemetry*. Slang would not be included.

b) Include selected terms from the basic sciences and mathematics which were used frequently in the definitions.

Type of Definitions.

c) Whenever possible use an operational definition (one which defines a concept in terms of actual operations by

which the defined quantity can be measured, rather than in terms of properties).

Source of Definitions. d) Base definitions or definitions already accepted as authoritative by a Government agency, a scientific or technical society, or a national or international standards organization. These definitions would not be accepted uncritically and would be modified when necessary to meet the need of the Dictionary.

This plan has, in general, been followed although limitations on time and personnel in the collecting and editing phases caused the coverage to be somewhat narrower than originally intended. For example, the editor recognizes that the fields of biotechnology and engineering psychology have relatively limited coverage in this edition.

METHOD OF PREPARATION

Word List. The first step in the preparation of the Dictionary was the selection of terms to be defined. In the selection process, the editor searched NASA publications, Congressional reports, publications of other Government agencies, existing technical dictionaries and glossaries, authoritative books in the disciplines contributing to space research, current reports on space-oriented research, and engineering journals. Simultaneously, authoritative definitions for the terms and citations showing usage were collected. The product of the search was a list of some 8,000 terms. This list was circulated among the NASA technical staff for comment and for recommendations on additions and deletions.

Revised List. Guided by the comments of the reviewers a revised word list was prepared. The number of terms was reduced to 6,000.

Definitions. The definitions compiled during the term selection process were evaluated and were rewritten where necessary to provide a uniform presentation. Where authoritative definitions could not be found, definitions were written based on usage by authorities in the fields concerned.

Review Draft. All definitions were assembled in page format and photographed to provide the plates for the printing of the *Review Draft* of the Dictionary. In November of 1961, 200 copies of the *Review Draft* were distributed to members of the NASA technical staff and to other authorities for review and comment. The reviewers provided specific comments, which required changes in more than half of the definitions, and general comments, which guided the reediting of all definitions. The necessary changes were made, and copy was delivered to the printer in July 1962.

Revision. The unavoidable delays inherent in the printing and proofreading processes have been utilized to gather new data that have been used in revising and updating each proof as it was read. It is the editor's opinion, based on his work with standardization activities of several technical societies, that the information is valid as of mid-1964.

RELATION TO OTHER DICTIONARIES AND GLOSSARIES

Aeronautical Dictionary. This Dictionary owes a great debt to the work of Frank Davis Adams, editor of the *NASA Aeronautical Dictionary* (now out of print). Many definitions were taken directly from the *Aeronautical Dictionary* and from source materials collected by Dr. Adams.

Air Force Dictionary. An equal debt is owed Woodford Agee Heflin, editor of the *Air Force Dictionary* and the *Aerospace Glossary.* Materials from both publications were used in this Dictionary.

It should be noted that both the *Air Force Dictionary* and the *NASA Aeronautical Dictionary* have done much to stabilize the language of aeronautics. Both are widely used by Government agencies and outside organizations, and both have been used as sources for other dictionaries. The *NASA Aeronautical Dictionary* has also been used as the basis for the *AGARD Aeronautical Multilingual Dictionary Supplement*, which translates most of the terms from the *Aeronautical Dictionary* into six languages.

Government Publications. In addition to the *NASA Aeronautical Dictionary* and the *Air Force Dictionary*, many other dictionaries and glossaries published by agencies of the U. S. Government have been used as sources for definitions. Most used were the *Navigation Dictionary* (U.S.N. Hydrographic Office Publication No. 220), the *Glossary of Arctic and Subarctic Terms* (U.S. Air Force), and the *Definitions of Terms Used in Geodetic and Other Surveys* (U.S. Coast and Geodetic Survey Special Publication No. 242). Publications of the Inter-Range Instrumentation Group (IRIG) also provided many definitions.

Society Publications. Publications of technical and scientific societies were another important source. The most used of these was the *Glossary of Meteorology* of the American Meteorological Society. This comprehensive work, sponsored by several agencies of the U. S. Government, served as source for many terms in physics and mathematics as well as in meteorology.

Standards. Many of the definitions in the Dictionary are based on definitions included in the published standards of technical societies and standards organizations.

The principal sources of this type were the publications of the American Standards Association, The Institute of Electrical and Electronic Engineers, and the American Vacuum Society. However, the definitions in this Dictionary should *not* be used as standards. They are not in the same form as the sources; most are abridged; the terms used in the definition may not be defined in this Dictionary precisely as they are defined in the applicable standard; and, most important, they are not referenceable to a specific, dated publication of a standards issuing organization. Users of this Dictionary are urged to turn to published standards in the particular field concerned for the rigorous definitions needed for writing such technical materials as specifications or test method descriptions.

Translation. The International Academy of Astronautics *Astronautical Multilingual Dictionary* (in press) contains translations of most of the terms in this Dictionary in six languages—Russian, German, French, Italian, Spanish, and Czech. The *Dictionary*

of Technical Terms for Aerospace Use was the source of almost nine tenths of the basic word list of the *Multilingual Dictionary*.

Bibliography. The principal sources consulted in the compilation of this Dictionary are listed in the Bibliography, at the end of the volume.

MANNER OF PRESENTATION

The manner of presentation emphasizes the technical content of the definitions and omits information on grammar usually given in general dictionaries. It is hoped that the definitions and the examples will identify the parts of speech and indicate whether a verb is transitive or intransitive. If these points are not clear, it may be assumed that usage is not consistent. Terms are entered in the singular without mention of the plural unless only the plural is used or unless the spelling of the plural is radically different from the singular, e.g., ***apsides.*** Plural of ***apsis.*** Variant spellings are entered in normal alphabetical order, e.g., ***apse*** = ***apsis.*** Abbreviations and acronyms are entered in normal alphabetical order.

The order of presentation is (*a*) the term, (*b*) symbols or abbreviations, (*c*) etymology or derivation, (*d*) definitions and examples, (*e*) synonyms and cross references, and (*f*) explanatory note in smaller type, as

Mach number (*symbols* $\boldsymbol{M}$, $\boldsymbol{N_{Ma}}$). (Pronounced *mock*, after Ernst Mach, 1838–1916, Austrian scientist.) A number expressing the ratio of the speed of a body or of a point on a body with respect to the surrounding air or other **fluid,** or the speed of a **flow,** to the **speed of sound** in the medium; the speed represented by this number. See **Cauchy number.**

If the Mach number is less than 1, the flow is called *subsonic* and local disturbances can propagate ahead of the flow. If the Mach number is greater than 1, the flow is called *supersonic* and disturbances cannot propagate ahead of the flow with the result that shock waves form.

Some authorities use *mach number* but engineering practice is to use a capital *M* in all words and combinations employing *Mach.*

Mach wave. **1.** A **shock wave** theoretically occurring along a common line of intersection of all the pressure disturbances emanating from an infinitesimally small particle moving at supersonic speed through a **fluid** medium, with such a wave considered to exert no changes in the condition of the fluid passing through it.

The concept of the Mach wave is used in defining and studying the realm of certain disturbances in a supersonic field of flow.

2. A very weak shock wave appearing, e.g., at the nose of a very sharp body, where the fluid undergoes no substantial change in direction.

Typography. **Bold face** is used for entries, the numeral and letters before definitions, for abbreviations immediately following an entry, and for cross references. Roman

is used for the body of the definitions and for notes (in smaller type). *Italic* is used in lieu of quotation marks to indicate that a term rather than a concept is being discussed. ***Italic bold face*** is used for symbols immediately following an entry.

Abbreviations and Symbols. The abbreviations and symbols included are those currently used in NASA publications and those recommended for national and international use by technical societies and standards organizations. For consistency, all abbreviations are printed without points between letters unless omission of points might cause misunderstanding. Omission of a particular symbol or abbreviation does *not* indicate NASA disapproval of the use of that symbol or abbreviation.

Definitions. The definitions of different senses for a given term are separated by numerals or letters. The letters are used as subheadings under a numbered heading or are used to indicate a close relationship between the different meanings.

Cross References. All terms printed in **bold face** are defined in the Dictionary. Cross references are indicated by the use of **bold face** both in the definition and in specific instructions following the definition, such as "see" and "compare". The cross references following the definition should be used for full understanding of the term defined. The cross references within the definition are used to indicate key terms of the definition which are also defined in the Dictionary.

Synonyms. Synonyms for terms defined are entered in normal alphabetical order followed by the symbol, = and a cross reference to the definition; as **circle of declination = hour circle**. The inclusion of a definition for only one of a group of synonyms does *not* mean that the use of another synonym is incorrect. It does mean that the evidence examined during the preparation of the Dictionary indicated that the term defined was the most commonly used.

Small-Type Notes. A note in smaller type, following the definition, is used to give additional information about the term defined. The information in a note is not considered essential to understanding of the Definition.

Mathematical Notation. In general, mathematical notations are defined as they occur. Because of the many sources for the definitions, a completely consistent system of notation could not be used throughout the Dictionary.

ACKNOWLEDGEMENTS

More than two hundred persons, most of them authorities in specific technical fields, assisted the editor in the selection of terms and in insuring the technical accuracy of definitions. It would have been impossible to prepare a useful dictionary without their assistance. Space does not permit listing the names of all who assisted, and it would be unfair to list only a few. However, specific credit must be given to Mrs. Dorothy Osolinsky who edited all copy for the Review Draft.

WILLIAM H. ALLEN
Editor

A

aberration. **1.** In astronomy, the apparent angular displacement of the position of a celestial body in the direction of motion of the observer, caused by the combination of the velocity of the observer and the velocity of light. See **constant of aberration, planetary aberration.** Compare **parallax.** **2.** In optics, a specific deviation from perfect imagery, as, for example: spherical aberration, coma, astigmatism, curvature of field, and distortion.

aberration constant = **constant of aberration.**

ablate. To carry away; specifically, to carry away heat generated by **aerodynamic heating,** from a vital part, by arranging for its absorption in a nonvital part, which may melt or vaporize, then fall away taking the heat with it. See **heat shield, ablation.**

ablating material. A material, especially a coating material, designed to provide thermal protection to a body in a fluid stream through loss of mass.

Ablating materials are used on the surfaces of some reentry vehicles to absorb heat by removal of mass, thus blocking the transfer of heat to the rest of the vehicle and maintaining temperatures within design limits.

Ablating materials absorb heat by increasing in temperature and changing in chemical or physical state. The heat is carried away from the surface by a loss of mass (liquid or vapor). The departing mass also blocks part of the convective heat transfer to the remaining material in the same manner as **transpiration cooling.**

ablating nose cone. A **nose cone** designed to reduce heat transfer to the internal structure by the use of an **ablating material.**

ablation. The removal of surface material from a body by vaporization, melting, chipping, or other erosive process; specifically, the intentional removal of material from a **nose cone** or **spacecraft** during high-speed movement through a planetary atmosphere to provide thermal protection to the underlying structure. See **ablating material.**

ablatively. By a process of ablation, as in *ablatively cooled.*

ablative material = **ablating material.**

ablator. A material designed to provide thermal protection through **ablation.**

abort. **1.** To cut short or break off an action, operation, or procedure with an aircraft, space vehicle, or the like, especially because of equipment failure, as *to abort a mission, the launching was aborted.* **2.** An aircraft, space vehicle, or the like that aborts. **3.** An act or instance of aborting.

Abridged Nautical Almanac. See **Nautical Almanac.**

absolute. **1.** Pertaining to a measurement relative to a universal constant or natural **datum,** as *absolute coordinate system, absolute altitude, absolute temperature.* **2.** Complete, as in *absolute vacuum.*

absolute altimeter. An instrument intended to give acceptably accurate, direct indications of **absolute altitude.**

absolute altitude. Altitude above the actual surface, either land or water, of a planet or natural satellite. Compare **true altitude.**

absolute coordinate system. An **inertial coordinate system** which is fixed with respect to the stars.

In theory, no absolute coordinate system can be established because the reference stars are themselves in motion. In practice, such a system can be established to meet the demands of the problem concerned by the selection of appropriate reference stars.

absolute delay. **1.** The time interval between the transmission of sequential signals. Also called *delay.* **2.** Specifically, in **loran,** the time interval between transmission of a signal from the A-station and transmission of the next signal from the B-station.

absolute humidity. The amount of water vapor actually present in unit quantity of a gas, generally expressed as mass of water vapor per unit volume of gas + water vapor, e.g., as grains per cubic foot.

absolute index of refraction = **index of refraction** (sense **1**).

absolute instrument. An instrument whose calibration can be determined by means of physical measurements on the instrument. Compare **secondary instrument.**

absolute magnitude (*symbol* ***M***). **1.** A measure of the brightness of a star equal to the **magnitude** the star would have at a distance of 10 **parsecs** from the observer.

$$M = m + 5 + 5 \log \pi$$

where m is apparent magnitude, and π is the parallax of the star (in seconds of arc).

Absolute magnitudes may be visual, photographic,

etc., according to the way in which the **apparent magnitude** was measured.

2. The stellar magnitude any **meteor** would have if placed in the observer's zenith at a height of 100 kilometers.

absolute manometer. **1.** A gas **manometer** whose calibration, which is the same for all ideal gases, can be calculated from the measurable physical constants of the instrument. **2.** A **manometer** that measures **absolute pressure.**

absolute motion. Motion relative to a fixed point. See **absolute coordinate system,** note.

absolute pressure. In engineering literature, a term used to indicate **pressure** above the absolute zero value of pressure that theoretically obtains in empty space or at the absolute zero of temperature as distinguished from *gage pressure.*

In high-vacuum technology, *pressure* is understood to correspond to absolute pressure, not gage pressure, and therefore the term *absolute pressure* is rarely used.

absolute refractive index = index of refraction (sense **1**).

absolute system of units. **1.** A system of units in which a small number of units are chosen as fundamental, and all other units are derived from them. **2.** Specifically, a system of electrical units put into effect by international agreement on 1 January 1948.

Prior to 1 January 1948 the international system was in effect; the two systems can be converted by the following relationships:

1 mean international ohm = 1.00049 absolute ohm
1 mean international volt = 1.00034 absolute volt.

absolute temperature. Temperature value relative to **absolute zero.**

absolute temperature scale. A temperature scale based upon the value zero as the lowest possible value. Thus, all obtainable temperatures are positive. The **Kelvin** and **Rankine** scales are absolute scales.

absolute vacuum. A void completely empty of matter. Also called *perfect vacuum.*

An absolute vacuum is not obtainable.

absolute vorticity. **1.** The vorticity of a fluid particle expressed with respect to an absolute coordinate system. **2.** The vertical component η of the absolute vorticity (as defined above).

absolute zero. The theoretical temperature at which molecular motion vanishes and a body would have no heat energy; the zero point of the **Kelvin** and **Rankine** temperature scales.

Absolute zero may be interpreted as the temperature at which the volume of a perfect gas vanishes or, more generally, as the temperature of the cold source which would render a Carnot cycle 100 percent efficient. The value of absolute zero is now estimated to be −273.15° Celsius, −459.67° Fahrenheit, 0° Kelvin, and 0° Rankine.

absorptance, absorbtance (*symbol* A, a, or α). The ratio of the radiant flux absorbed by a body to that incident upon it. Also called **absorption factor.** Compare **absorptivity.**

Total absorptance refers to absorptance measured over all wavelengths.

Spectral absorptance refers to absorptance measured at a specified wavelength.

absorption. **1.** The process by which radiant energy is absorbed and converted into other forms of energy. See **attenuation.**

Absorption takes place only after the radiant flux enters a medium and thus acts only on the entering flux not on the incident flux, some of which may be reflected at the surface of the medium.

A substance which absorbs energy may also be a medium of **refraction, diffraction,** or **scattering;** these processes, however, involve no energy retention or transformation and are to be clearly differentiated from absorption.

2. In general, the taking up or assimilation of one substance by another. See **sorption, adsorption.** **3.** In vacuum technology, gas entering into the interior of a solid.

absorption band. A range of wavelengths (or frequencies) in the **electromagnetic spectrum** within which radiant energy is absorbed by a substance. See **absorption spectrum.**

When the absorbing substance is a polyatomic gas, an absorption band actually is composed of a group of discrete absorption lines which appear to overlap. Each line is associated with a particular mode of vibration or rotation induced in a gas molecule by the incident radiation.

The absorption bands of oxygen and ozone are often referred to in the literature of atmospheric physics.

The important bands for oxygen are: (**a**) the Hopfield bands, very strong, between about 670 and 1000 angstroms in the ultraviolet; (**b**) a diffuse system between 1019 and 1300 angstroms; (**c**) the Schumann-Runge continuum, very strong, between 1350 and 1760 angstroms; (**d**) the Schumann-Runge bands between 1760 and 1926 angstroms; (**e**) the Herzberg bands between 2400 and 2600 angstroms; (**f**) the atmospheric bands between 5380 and 7710 angstroms in the visible spectrum; and (**g**) a system in the infrared at about 1 micron.

The important bands for ozone are: (**a**) the Hartley bands between 2000 and 3000 angstroms in the ultraviolet, with a very intense maximum absorption at 2550 angstroms; (**b**) the Huggins bands, weak absorption between 3200 and 3600 angstroms; (**c**) the Chappius bands, a weak diffuse system between 4500 and 6500 angstroms in the visible spectrum; and (**d**) the infrared bands centered at 4.7, 9.6, and 14.1 microns, the latter being the most intense.

absorption coefficient (*symbol* α). **1.** A measure of the amount of normally incident **radiant energy** absorbed through a unit distance or by a unit mass of absorbing medium. Compare **transmission coefficient.**

The absorption coefficient is frequently identified as follows:

$$I_{\lambda x} = I_{\lambda 0} e^{-k^{\lambda} x}$$

where $I_{\lambda x}$ is the flux density of radiation of wavelength λ,

initially of flux density I_{λ_0}, after traversing a distance x in some absorbing medium.

2. In **acoustics,** the ratio of the sound energy absorbed by a surface of a medium (or material) exposed to a sound field or sound radiation to the sound energy incident on the surface. The stated values of this ratio are to hold for an infinite area of the surface. The conditions under which measurements of absorption coefficients are made are to be stated explicitly.

Three types of absorption coefficients associated with three methods of measurement are: chamber absorption coefficient, obtained in a certain reverberation chamber; free-wave absorption coefficient, obtained when a plane, progressive, sound wave is incident on the surface of the medium; sabine absorption coefficient, obtained when the sound is incident from all directions on the sample.

absorption cross section. In radar, the ratio of the amount of power removed from a beam by absorption of radio energy by a target to the power in the beam incident upon the target. Compare **scattering cross section.** See **cross section.**

absorption-emission pyrometer. A thermometer for determining gas temperature from measurement of the radiation emitted by a calibrated reference source before and after this radiation has passed through and been partially absorbed by the gas. Both measurements are made over the same wavelength interval.

absorption factor = absorptance.

absorption line. A minute range of wavelength (or frequency) in the **electromagnetic spectrum** within which radiant energy is absorbed by the medium through which it is passing. Each line is associated with a particular mode of electronic excitation induced in the absorbing atoms by the incident radiation. See **absorption spectrum, spectral line, telluric lines, Fraunhofer lines, absorption band.**

absorption spectrum. The array of **absorption lines** and **absorption bands** which results from the passage of radiant energy from a continuous source through a selectively absorbing medium cooler than the source. See **electromagnetic spectrum.**

The absorption spectrum is a characteristic of the absorbing medium, just as an **emission spectrum** is a characteristic of a radiator.

An absorption spectrum formed by a monatomic gas exhibits discrete dark lines, whereas that formed by a polyatomic gas exhibits ordered arrays (bands) of dark lines, which appear to overlap. This type of absorption is often referred to as *line absorption.* The spectrum formed by a selectively absorbing liquid or solid is typically continuous in nature (continuous absorption).

absorptive index. The imaginary part of the complex **index of refraction** of a medium. It represents the energy loss by absorption and has a nonzero value for all media which are not dielectrics. Also called *index of absorption.* Compare **absorption coefficient.**

absorptive power. The total flux of radiant energy absorbed in a unit area of absorbing substance; expressed, for example, in ergs per square centimeter per second or in watts per square centimeter.

absorptivity (*symbol* A_∞). The capacity of a material to absorb incident radiant energy, measured as the **absorptance** of a specimen of the material thick enough to be completely opaque, and having an optically smooth surface.

absorptivity-emissivity ratio. In space applications, the ratio of absorptivity for **solar radiation** of a material to its infrared emissivity. Also called *A/E ratio.*

acceleration. **1.** The rate of change of **velocity.** **2.** The act or process of accelerating, or the state of being accelerated. Negative acceleration is called *deceleration.*

acceleration of gravity (*symbol* g). By the International Gravity Formula, $g = 978.0495 [1 + 0.0052892 \sin^2\phi - 0.0000073 \sin^2 2\phi]$ centimeters per second squared at sea level at latitude ϕ. See **gravity.**

The standard value of gravity, or normal gravity, g, is defined as $g_o = 980.665$ centimeters per second squared, or 32.1741 feet per second squared. This value corresponds closely to the International Gravity Formula value of g at 45° latitude at sea level.

accelerator. Short for *particle accelerator.*

accelerometer. A **transducer** which measures acceleration or gravitational forces capable of imparting **acceleration.**

An accelerometer usually uses a concentrated mass (seismic mass) which resists movement because of its inertia. The displacement of the seismic mass relative to its supporting frame or container is used as a measure of acceleration.

acceptor. In **transistors,** the P-type semiconductor, the electrode containing trivalent impurities (boron, gallium, or indium) to increase the number of holes which can accept electrons. Contrast with **donor.**

accidental error. In experimental observations, an **error** which does not always recur when an observation is repeated under the same conditions. Contrast **systematic error.**

acclimatization. The adjustments of a human body or other organism to a new environment; the bodily changes which tend to increase efficiency and reduce energy loss. Compare **adaptation, accustomization.**

accommodation coefficient (*symbol* α). The ratio of the average energy actually transferred between a surface and impinging gas molecules which are scattered by the surface to the average energy which would theoretically be trans-

ferred if the impinging molecules reached complete thermal equilibrium with the surface before leaving the surface, or

$$a = (E_r - E_i)/(E_s - E_i)$$

where E_r is the energy carried away from unit surface area per second by the scattered or re-evaporated molecules, E_i is the energy per unit surface area per second carried toward the surface by the impinging molecules, and E_s is the energy per unit surface area per second which would be carried away by the molecules if the molecules reached complete thermal equilibrium with the surface before leaving.

accumulator. **1.** A device or apparatus that accumulates or stores up, as: (**a**) a contrivance in a hydraulic system that stores fluid under pressure; (**b**) a device sometimes incorporated in the fuel system of a gas-turbine engine to store up and release fuel under pressure as an aid in starting; (**c**) an electrical storage battery (British usage). **2.** In computer technology, a device which stores a number and upon receipt of another number adds it to the number already stored and stores the sum. See **counter.**

accustomization. The process of learning the techniques of living with a minimum of discomfort in an extreme or new environment. Compare **acclimatization, adaptation.**

aclinic line. The line through those points on the earth's surface at which **magnetic dip** is zero. The aclinic line is a particular case of an **isoclinic line.** Also called *dip equator, magnetic equator.* Compare **agonic line, geomagnetic equator.**

acoustic, acoustical. Containing, producing, arising from, actuated by, related to, or associated with **sound.**

Acoustic is used to modify terms that designate an object, or physical characteristics, associated with sound waves; *acoustical* is used when the term being qualified does not designate explicitly something that has such properties, dimensions, or physical characteristics.

The following terms are examples of those modified by *acoustic:* impedance, inertance, load (radiation field), output (sound power), energy, wave, medium, signal, conduit, absorptivity, transducer.

The following examples do not have the requisite physical characteristics and therefore take *acoustical:* society, method, engineer, school, glossary, symbol, problem, measurement, point of view, device.

As illustrated, the generic term is usually modified by *acoustical,* whereas the specific technical term calls for *acoustic.*

acoustic delay line. A device used in a communications link or a computer **memory** in which the signal is delayed by the propagation of a sound wave. Also called *sonic delay line.*

acoustic dispersion. The change of speed of sound with **frequency.**

acoustic excitation. The process of inducing **vibration** in a structure by exposure to **sound waves.**

acoustic generator. A **transducer** which converts electric, mechanical, or other forms of energy into **sound.**

acoustic Mach meter. A device which obtains data on sound propagation for the calculation of **Mach number.**

Some acoustic Mach meters measure transit time or velocity of a sound pulse; others measure an angle, as the angle of the **Mach cone.**

acoustic radiation pressure. A unidirectional, steady-state pressure exerted upon a surface exposed to a **sound wave.**

acoustic refraction. The process by which the direction of **sound propagation** is changed due to spatial variation in the **speed of sound** in the medium.

acoustics. **1.** The study of **sound,** including its production, transmission, and effects. **2.** Those qualities of an enclosure that together determine its character with respect to distinct hearing.

acoustic streaming. Unidirectional flow currents in a fluid that are due to the presence of **sound waves.**

acoustic velocity (*symbol* a) = **speed of sound.**

acoustic vibration. With respect to operational **environments, vibrations** transmitted through a gas. These vibrations may be **subsonic, sonic,** and **ultrasonic.**

acoustic wave = **sound wave.**

acquisition. **1.** The process of locating the orbit of a satellite or trajectory of a space probe so that tracking or telemetry data can be gathered. **2.** The process of pointing an antenna or telescope so that it is properly oriented to allow gathering of tracking or telemetry data from a satellite or space probe.

acquisition and tracking radar. A radar set that locks onto a strong signal and tracks the object reflecting the signal.

actinic. Pertaining to **electromagnetic radiation** capable of initiating photochemical reactions, as in photography or the fading of pigments.

Because of the particularly strong action of ultra violet radiation on photochemical processes, the term has come to be almost synonymous with **ultraviolet,** as in *actinic rays.*

actinic balance = **bolometer.**

actinogram. The record of a recording **actinometer.**

actinograph. A recording **actinometer.**

actinometer. The general name for any instru-

ment used to measure the intensity of **radiant energy,** particularly that of the sun. See **actinometry.** See also **bolometer, dosimeter, photometer, radiometer.**

Actinometers may be classified, according to the quantities which they measure, in the following manner: (a) pyrheliometer, which measures the intensity of direct solar radiation; (b) pyranometer, which measures global radiation (the combined intensity of direct solar radiation and diffuse sky radiation); and (c) pyrgeometer, which measures the **effective terrestrial radiation.**

actinometry. The science of measurement of radiant energy, particularly that of the sun, in its thermal, chemical, and luminous aspects. Compare **photometry.** See **actinometer.**

active. **1.** Transmitting a signal, as *active satellite.* Antonym of *passive.* **2.** = **radioactive,** as *active sample.* **3.** = **fissionable,** as *active material.* **4.** Receiving energy from some source other than a signal, as *active element.*

active element. In a **computer,** a **circuit** or device which receives energy from some source other than the signal input.

active homing. The **homing** of an aerodynamic or space vehicle in which energy waves (as radar) are transmitted from the vehicle to the target and reflected back to the vehicle to direct the vehicle toward the target. Compare **passive homing.**

active homing guidance. See **homing guidance.**

active leg. An electrical element within a **transducer** which changes its electrical characteristics as a function of the application of a stimulus.

active satellite. A **satellite** which transmits a signal, in contrast to *passive satellite.*

active tracking system. A system which requires addition of a **transponder,** or **transmitter** on board the vehicle to repeat, transmit, or retransmit information to the tracking equipment, e.g., **Dovap, Secor, Azusa, Miran, Minitrack.**

active transducer. A **transducer** whose output is dependent upon sources of power, apart from that supplied by any of the actuating signals, which power is controlled by one or more of these signals.

actuating system. A mechanical system that supplies and transmits energy for the operation of other mechanisms or systems.

adaptation. The adjustment, alteration, or modification of an organism to fit it more perfectly for existence in its environment. Compare **acclimatization, accustomization.**

Adaptation is applied particularly to evolutionary change.

adaptation brightness = **adaptation luminance.**

adaptation illuminance = **adaptation luminance.**

adaptation level = **adaptation luminance.**

adaptation luminance. The average **luminance** (or brightness) of those objects and surfaces in the immediate vicinity of an observer. Also called *adaptation brightness, adaptation level, adaptation illuminance.*

The adaptation luminance has a marked influence on an observer's estimate of the **visual range** because, along with the visual angle of the object under observation, it determines the observer's **threshold contrast.** High adaptation luminance tends to produce a high threshold contrast, thus reducing the estimated visual range. This effect of the adaptation luminance is to be distinguished from the influence of **background luminance.**

adapter. **1.** Any device or contrivance used or designed primarily to fit or adjust one thing to another, as: (a) a buckle or clip on a parachute harness, used in adjusting the harness to the wearer; (b) a joint attaching an afterburner to a turbine casing on a jet engine; (c) a fitting for connecting pipes, valves, etc., that have different types of threads. **2.** Any device, appliance or the like used to alter something so as to make it suitable for a use for which it was not originally designed.

adapter skirt. A flange or extension of a **space-vehicle stage** or section that provides a ready means for fitting some object to the stage or section.

adaptive control system. A control system which continuously monitors the dynamic response of the controlled system and automatically adjusts critical system parameters to satisfy preassigned response criteria, thus producing the same response over a wide range of environmental conditions.

ADC (*abbr*) = **analog to digital converter.**

Adcock antenna. A pair of vertical antennas separated by a distance of one-half **wavelength** or less, and connected in **phase opposition** to produce a **radiation pattern** having the shape of a figure eight.

adder. In a **computer,** a device which can form the sum of two or more numbers or quantities.

additional apparent mass = **apparent additional mass.**

additive. Any material or substance added to something else. Specifically, a substance added to a **propellant** to achieve some purpose, such as a more even rate of combustion, or a substance added to fuels or lubricants to improve them or give them some desired quality,

such as tetraethyl lead added to a fuel as an antidetonation agent, or graphite, talc, or other substances added to certain oils and greases to improve lubrication qualities.

address. **1.** Of a **computer,** a location where information is stored. **2.** An expression, usually numerical, identifying an address (sense **1**).

ADF (*abbr*) = ***a*utomatic *d*irection *f*inder.**

adiabat. A line on a **thermodynamic diagram** representing a constant **potential temperature.** See **adiabatic process.**

adiabatic. Without gain or loss of heat.

adiabatic atmosphere. A model atmosphere in which the pressure decreases with height according to:

$$p = p_0 \, [1 - (-gz/c_{p,d}T_0)] \; c_{p,d}R_d$$

where p_0 and T_0 are the pressure and temperature (°K) at sea level or other datum; z is the geometric height; R_d is the gas constant for dry gas; $c_{p,d}$ is the specific heat for dry gas at constant pressure; and g is the acceleration of gravity. Also called *dry-adiabatic atmosphere, convective atmosphere, homogeneous atmosphere.* See **homogeneous atmosphere, barotropy.**

adiabatic compression. See **adiabatic process.**

adiabatic efficiency. The efficiency with which work is done with respect to heat gains or losses. See **adiabatic process.**

adiabatic equivalent temperature. See **equivalent temperature,** sense **2.**

adiabatic process. A **thermodynamic** change of state of a system in which there is no transfer of heat or mass across the boundaries of the system. In an adiabatic process, compression always results in warming, expansion in cooling. See **diabatic process.**

adiabatic recovery temperature. **1.** The temperature reached by a moving fluid when brought to rest through an **adiabatic process.** Also called *recovery temperature, stagnation temperature.* **2.** = **adiabatic wall temperature.** **3.** The final and initial temperature in an adiabatic, **Carnot cycle.**

adiabatic wall temperature. The temperature assumed by a wall in a moving fluid stream when there is no heat transfer between the wall and the stream.

A-display. In radar, a **display** in which **targets** appear as vertical deflections from a line representing a time base. Also called *A-scan* or *A-scope.*

Target distance is indicated by the horizontal position of the deflection from one end of the time base. The amplitude of the vertical deflection is a function of the signal intensity.

ADP (*abbr*) = ***a*utomatic *d*ata *p*rocessing.**

adsorbate. In the process of **adsorption,** the adsorbed substance.

adsorbent. A material which takes up gas by **adsorption.**

adsorption. The adhesion of a thin film of liquid or gas to the surface of a solid substance. The solid does not combine chemically with the adsorbed substance. See **sorption, absorption, chemisorption.**

advection. The process of transport of an atmospheric property solely by the mass motion of the atmosphere; also, the rate of change of the value of the advected property at a given point.

Regarding the general distinction (in meteorology) between *advection* and *convection,* the former describes the predominantly horizontal, large-scale motions of the atmosphere whereas *convection* describes the predominantly vertical, locally induced motions.

advective. Pertaining to *advection.*

aeon. 10^9 years.

This term was suggested by Harold Urey in 1957.

A/E ratio = **absorptivity-emissivity ratio.**

aerial. **1.** = **antenna.** **2.** Of or pertaining to the air, atmosphere, or aviation.

aeroastromedicine = **aerospace medicine.**

aeroballistics. The study of the interaction of projectiles or high speed vehicles with the atmosphere. See **ballistics.**

The problem of the effect of reentry on the trajectory of a vehicle is a problem in aeroballistics.

aerobiology. The study of the distribution of living organisms freely suspended in the atmosphere.

aerodontalgia. A toothache brought on by a change in ambient pressure.

aeroduct. A **ramjet** type of engine designed to scoop up ions and electrons freely available in the outer reaches of the atmosphere or in the atmospheres of other spatial bodies, and by a **metachemical** process within the duct of this engine, expel particles derived from the ions and electrons as a propulsive jetstream.

aerodynamic. Of or pertaining to **aerodynamics.**

aerodynamic coefficient. Any nondimensional **coefficient** relating to aerodynamic forces or moments, such as a coefficient of drag, a coefficient of lift, etc.

aerodynamic force. The force exerted by a moving gaseous fluid upon a body completely immersed in it.

The aerodynamic force is proportional to the expression.

$\rho\, u^2 L^2 R^n$

where ρ is the fluid density; u is the velocity of the undisturbed stream relative to the body; L is a characteristic linear dimension of the body; and R^n is the Reynolds number raised to the power of n, a constant usually determined experimentally. This form for the aerodynamic force is sometimes called *Rayleigh formula*. The component of the aerodynamic force parallel to the direction of flow is called the *drag*.

aerodynamic heating. The heating of a body produced by passage of air or other gases over the body; caused by friction and by compression processes and significant chiefly at high speeds. See **radiative heating.**

aerodynamics. **1.** The science that deals with the motion of air and other gaseous fluids, and of the forces acting on bodies when the bodies move through such fluids, or when such fluids move against or around the bodies, as, *his research in aerodynamics.* **2.** (**a**) The actions and forces resulting from the movement or flow of gaseous fluids against or around bodies, as, *the aerodynamics of a wing in supersonic flight.* (**b**) The properties of a body or bodies with respect to these actions or forces, as, *the aerodynamics of a turret or of a configuration.* **3.** The application of the principles of gaseous fluid flows and of their actions against and around bodies to the design and construction of bodies intended to move through such fluids, as *a design used in aerodynamics.*

aerodynamic trail. A condensation trail formed by **adiabatic** cooling to saturation (or slight supersaturation) of air passing over the surfaces of high-speed aircraft.

Aerodynamic trails form off the tips of wings and propellers and other points of maximum pressure decrease. They are relatively rare and of short duration compared to **exhaust trails.**

aerodynamic vehicle. A device, such as an airplane, glider, etc., capable of flight only within a **sensible atmosphere** and relying on aerodynamic forces to maintain flight.

The term is used when the context calls for discrimination from *space vehicle.*

aeroelasticity. The study of the response of structurally elastic bodies to **aerodynamic** loads.

aeroembolism. **1.** The formation or liberation of gases in the blood vessels of the body, as brought on by a too-rapid change from a high, or relatively high, atmospheric pressure to a lower one. **2.** The disease or condition caused by the formation of gas bubbles (mostly nitrogen) in the body fluids. The disease is characterized principally by neuralgic pains, cramps, and swelling, and sometimes results in death. Also called *decompression sickness.*

aeroemphysema. A swelling condition caused by the formation of gas in the tissues of the body.

aerolite. A **meteorite** composed principally of stony material.

aerology. **1.** As officially used in the U. S. Navy until early 1957, same as **meteorology;** this usage was more administrative than scientific. **2.** As a subdivision of meteorology, the study of the **free atmosphere** throughout its vertical extent, as distinguished from studies confined to the layer of the atmosphere adjacent to the earth's surface.

aeronomy. The study of the upper regions of the atmosphere where ionization, dissociation, and chemical reactions take place.

aero-otitis media. An inflammatory reaction of the middle ear resulting from a difference in pressure between the gas in the middle ear and the surrounding atmosphere. Also called *otitic barotrauma.*

aeropause. A region of indeterminate limits in the upper atmosphere, considered as a boundary or transition region between the denser portion of the **atmosphere** and **space.**

From a functional point of view, it is considered to be that region in which the atmosphere is so tenuous as to have a negligible, or almost negligible, effect on men and aircraft, and in which the physiological requirements of man become increasingly important in the design of aircraft and auxiliary equipment.

aerophare = radio beacon.

aeropulse engine = pulsejet engine.

aerosinusitis. An inflammatory reaction of one or more of the accessory nasal sinuses resulting from a difference in pressure between the gas in the sinus and the surrounding atmosphere. Also called *sinus barotrauma.*

aerosonator = resojet engine.

aerospace. (From *aero*nautics and *space*). **1.** Of or pertaining to both the earth's **atmosphere** and **space,** as in *aerospace industries.* **2.** Earth's envelope of air and space above it; the two considered as a single realm for activity in the flight of air vehicles and in the launching, guidance, and control of ballistic missiles, earth satellites, dirigible space vehicles, and the like.

Aerospace in sense 2 is used primarily by the U.S. Air Force.

The term *aerospace* first appeared in print in the *Interim Glossary*; *Aero-Space Terms* (edited by Woodford Agee Heflin) published in February 1958 at the Air University, Maxwell Air Force Base, Alabama.

aerospace medicine. That branch of medicine dealing with the effects of flight through the atmosphere or in space upon the human body and with the prevention or cure of physiological or psychological malfunctions arising from these effects.

aerospace vehicle. A vehicle capable of flight within and outside the **sensible atmosphere.**

aerothermodynamic border. An altitude at about 100 miles, above which the atmosphere is so rarefied that the skin of an object moving through it at high speeds generates no significant heat.

aerothermodynamic duct. The full term for *athodyd.*

aerothermodynamics. The study of **aerodynamic** phenomena at sufficiently high gas velocities that **thermodynamic** properties of the gas are important.

aerothermoelasticity. The study of the response of elastic structures to the combined effects of **aerodynamic heating** and loading.

AFC (*abbr*) = **automatic frequency control.**

afterbody. **1.** A **companion body** that trails a **satellite.** **2.** A section or piece of a **rocket** or **spacecraft** that enters the atmosphere unprotected behind the nose cone or other body that is protected for entry. **3.** The afterpart of a vehicle.

afterburner. A device for augmenting the thrust of a **jet engine** by burning additional fuel in the uncombined oxygen in the gases from the turbine.

afterburning. **1.** Irregular burning of fuel left in the **firing chamber** of a rocket after **fuel cutoff.** **2.** The function of an **afterburner,** a device for augmenting the thrust of a jet engine by burning additional fuel in the uncombined oxygen in the gases from the turbine.

aftercooling. **1.** The cooling of a gas after compression. **2.** The necessary cooling of a **reactor core** after its shutdown by pumping a liquid or gas through it to carry off the excess heat generated by continuing radioactive decay of fission products within the core.

afterglow. **1.** A broad, high arch of radiance or glow seen occasionally in the western sky above the highest clouds in deepening twilight, caused by the scattering effect of very fine particles of dust suspended in the upper atmosphere. **2.** The transient decay of a **plasma** after the power has been turned off.

The decay time involved is a direct consequence of the charged particle loss mechanisms, such as **diffusion** and **recombination.** The magnitude of these quantities is determined by measuring the decay time under controlled conditions.

afterheat. The heat generated in a **reactor core** after shutdown by continuing radioactive decay of fission products.

AGE (*abbr*) = **aerospace ground equipment.** See **GSE.**

age of the moon. The elapsed time, usually expressed in days, since the last new moon. See **phases of the moon.**

aging. In a metal or alloy, a change in properties that generally occurs slowly at room temperature and more rapidly at higher temperatures.

Agiwarn. Code name for the Western Hemisphere Regional Center for the IGY World Warning Agency.

agonic line. A line joining points at which the **magnetic variation** is zero. The **agonic line** is a particular case of an **isogonic line.**

agravic. Of or pertaining to a condition of no **gravitation.** See **weightlessness.**

agravic illusion. An apparent movement of a target in the visual field due to **otolith** response in zerogravity. Also called *oculoagravic illusion.*

air. **1.** The mixture of gases comprising the earth's atmosphere.

The percent by volume of those gases found in relatively constant amount in dry air near sea level is very nearly as follows:

	%
nitrogen (N_2)	78.084
oxygen (O_2)	20.9476
argon (A)	0.934
carbon dioxide (CO_2)	0.0314 (variable)
neon (Ne)	0.001818
helium (He)	0.000524
methane (CH_4)	0.0002 (variable)
krypton (Kr)	0.000114
hydrogen (H_2)	0.00005
nitrous oxide (N_2O)	0.00005
xenon (Xe)	0.0000087

In addition to the above constituents there are many variable constituents. Chief of these is water vapor, which may vary from zero to volume percentages close to 4 percent. Ozone, sulfur dioxide, ammonia, carbon monoxide, iodine, and other trace gases occur in small and varying amounts.

The above composition of dry air is true to about 90 kilometers. See **upper atmosphere.**

2. The realm or medium in which **aircraft** operate.

air breakup. The breakup of a test **reentry body** after reentry into the atmosphere.

Air breakup is sometimes provided for, as by the firing of a cartridge inside the reentry body, so as to retard the fall of certain pieces and increase the chances of their recovery. See **blowoff.**

airbreather. An **aerodynamic vehicle** propelled by fuel oxidized by intake from the atmosphere; an airbreathing vehicle.

airbreathing. Of an engine or **aerodynamic vehicle,** required to take in air for the purpose of combustion.

aircraft. Any structure, machine, or contrivance, especially a **vehicle,** designed to be supported by the air, being borne up either by the dynamic action of the air upon the surfaces of the structure or object, or by its own buoyancy;

such structures, machines, or vehicles collectively, as, *fifty aircraft.*

Aircraft, in its broadest meaning, includes fixed-wing airplanes, helicopters, gliders, airships, free and captive balloons, ornithopters, flying model aircraft, kites, etc., but since the term carries a strong vehicular suggestion, it is more often applied, or recognized to apply, only to such of these craft as are designed to support or convey a burden in or through the air.

aircraft rocket. A rocket **missile** designed to be carried by, and launched from, an **aircraft.**

airflow. A flow or stream of air. An airflow may take place in a wind tunnel, in the induction system of an engine, etc., or a relative airflow can occur, as past the wing or other parts of a moving craft; a rate of flow, measured by mass or volume per unit of time. See **flow.**

airfoil. A structure, piece, or body, originally likened to a foil or leaf in being wide and thin, designed to obtain a useful reaction on itself in its motion through the air.

airframe. The assembled structural and aerodynamic components of an **aircraft** or **rocket vehicle** that support the different systems and subsystems integral to the vehicle.

The word *airframe*, a carryover from aviation usage, remains appropriate for rocket vehicles since a major function of the airframe is performed during flight within the atmosphere.

There is disagreement as to whether the nose cone and combustion chambers are included in the term *airframe* while they are attached to the vehicle.

airglow. The quasi-steady radiant emission from the upper atmosphere as distinguished from the sporadic emission of the auroras.

Airglow is a **chemiluminescence** due primarily to the emission of the molecules O_2 and N_2, the radical OH, and the atoms O and Na. Emissions observed in airglow could arise from three-body atom collisions forming molecules, from two-body reactions between atoms and molecules, or from recombination of ions.

Historically, *airglow* has referred to visual radiation. Some recent studies use *airglow* to refer to radiation outside the visual range.

air launch. To launch from an aircraft in the air, as to *air launch a guided missile.*

air light. Light from sun and sky which is scattered into the eyes of an observer by atmospheric **suspensoids** (and, to slight extent, by air molecules) lying in the observer's cone of vision. That is, air light reaches the eye in the same manner that diffuse sky radiation reaches the earth's surface.

Air light is not to be confused with *airglow.*

air lock. **1.** A stoppage or diminution of flow in a fuel system, hydraulic system, or the like, caused by a pocket of air or vapor. **2.** A chamber capable of being hermetically sealed that provides for passage between two places of different pressure, as between an altitude chamber and the outside atmosphere.

air position indicator (*abbr* **API**). An airborne computing system which presents a continuous indication of the aircraft position on the basis of aircraft heading, airspeed, and elapsed time.

airscoop. A hood or open end of an air duct or a similar structure, projecting into the **airstream** about a vehicle in such a way as to utilize the motion of the vehicle in capturing air to be conducted to an engine, a ventilator, etc.

air shower. A grouping of cosmic-ray particles observed in the atmosphere; a **cascade shower** in the **atmosphere.** Also called *shower.*

Primary cosmic rays slowed down in the atmosphere emit **bremsstrahlung** photons of high energy. Each of these **photons** produces secondary **electrons** which generate more photons and the process continues until the available energy is absorbed.

airsickness. Motion sickness occurring in flight.

air sounding. The act of measuring atmospheric phenomena or determining atmospheric conditions at altitude, especially by means of apparatus carried by balloons or rockets. See **sounding.**

airspace. Specifically, the **atmosphere** above a particular portion of the earth, usually defined by the boundaries of an area on the surface projected upward.

Airspace is sometimes particularized by altitude, as the airspace above 20,000 feet.

air-space. Of or pertaining to both the atmosphere and space.

Because this adjective is pronounced as the noun *airspace* is, it is subject to misunderstanding. *Aerospace* is commonly used instead.

airstart. An act or instance of starting an aircraft's engine while in flight, especially a **jet engine** after flameout. Compare **in-flight start, ground start.**

airstream = **airflow.**

air vane. A **vane** that acts in the air, as contrasted to a **jet vane** which acts within a **jetstream.** See **control vane.**

air vehicle = **aircraft.**

Aitken dust counter. An instrument developed by John Aitken for determining the dust content of the atmosphere. In operation, a sample of air is mixed, in an expandable chamber, with a larger volume of dust-free air containing water vapor. Upon a sudden expansion, the chamber cools adiabatically below its dewpoint, and droplets form with the dust particles as nuclei (**Aitken nuclei**). A portion of these droplets settle on a ruled plate in the

instrument and are counted with the aid of a microscope. Also called *Aitken nucleus counter.*

Aitken nuclei. The microscopic particles in the atmosphere which serve as **condensation nuclei** for droplet growth during the rapid **adiabatic** expansion produced by an **Aitken dust counter.** These nuclei are both solid and liquid particles whose diameters are of the order of tenths of microns or even smaller.

The Aitken nuclei play an important role in atmospheric electrical processes, for they are the particles which capture (by adsorption or other surface electrical processes) small ions and thereby form large ions. In air containing large numbers of Aitken nuclei, the **small ion** population is small, the **large ion** population is large, and the air conductivity is low.

Aitken nucleus counter = Aitken dust counter.

albedo. The ratio of the amount of **electromagnetic radiation** reflected by a body to the amount incident upon it, often expressed as a percentage, as, *the albedo of the earth is 34%.* Compare **Bond albedo.**

The concept defined above is identical with **reflectance.** However, *albedo* is more commonly used in astronomy and meteorology and *reflectance* in physics.

Albedo is sometimes used to mean the flux of the reflected radiation as, *the earth albedo is 0.64 calorie per square centimeter.* This usage should be discouraged.

The *albedo* is to be distinguished from the **spectral reflectance,** which refers to one specific wavelength (monochromatic radiation).

Usage varies somewhat with regard to the exact wavelength interval implied in albedo figures; sometimes just the visible portion of the spectrum is considered, sometimes the totality of wavelengths in the solar spectrum.

albedometer. An instrument used for the measurement of the reflecting power, the **albedo,** of a surface.

A **pyranometer** adapted for the measurement of radiation reflected from the earth's surface is sometimes employed as an albedometer.

Alford loop. A multielement antenna, having approximately equal and in-phase currents uniformly distributed along each of its peripheral elements, producing a substantially circular radiation pattern in the plane of polarization.

Alfvén Mach number. The ratio of the local **flow** velocity to the local Alfvén speed. See **Alfvén wave.**

Alfvén speed. The speed at which **Alfvén** waves are propagated along the magnetic field.

For a perfectly conducting fluid with a mass density of 1 kilogram per cubic meter in a magnetic field of 10,000 gauss, the Alfvén speed is about 1,000 meters per second while the speed of sound in air is about 300 meters per second.

Alfvén wave. A transverse wave in a **magnetohydrodynamic** field in which the driving force is the tension introduced by the magnetic field along the lines of force. Also called *magnetohydrodynamic wave.*

The dynamics of such waves are analogous to those in a vibrating string, the **phase speed** C being given by

$$C^2 = \mu H^2/4\pi\rho$$

where μ is the permeability; H is the magnitude of the magnetic field; and ρ is the fluid density. Dissipative effects due to fluid viscosity and electrical resistance may also be present.

alga (*plural,* **algae**). Any plants of a group of unicellular and multicellular primitive organisms that include the Chlorella, Scenedesmus, and other genera.

The green algae and blue-green algae, for example, provide a possible means of photosynthesis in a **closed ecological system,** also a source of food.

algorism. The art or system of calculating with any species of notation, as in arithmetic with nine figures and a zero. Also called *algorithm.*

Different algorisms have been used in the design of computing machines.

algorithm. 1. A special mathematical procedure for solving a particular type of problem. **2. = algorism.**

alidade. That part of an optical measuring instrument comprising the optical system, indicator, vernier, etc.

In modern practice the term is used principally to refer to a telescope mounted over a compass or compass repeater to facilitate observation of bearings, and to a surveying instrument consisting of a telescope mounted over a compass rose, for measuring directions.

alkali metal. A metal in group IA of the periodic system; namely, lithium, sodium, potassium, rubidium, cesium, and francium.

Alkali metals are being considered as coolants (in liquid state) for nuclear reactors for spacecraft. See **liquid-metal corrosion.**

all burnt. The time at which a rocket consumes its propellants. See **burnout,** note.

all-inertial guidance. The **guidance** of a rocket vehicle entirely by use of inertial devices; the equipment used for this.

alloy. A substance having metallic properties and being composed of two or more chemical elements of which at least one is an elemental metal.

alloying element. An element added to a metal to effect changes in properties and which remains within the metal.

almucantar = parallel of altitude.

alpha decay. The radioactive transformation of a **nuclide** by **alpha-particle** emission. Also called *alpha disintegration.*

The decay product is the nuclide having a **mass number** four units smaller and an **atomic number** two units smaller than the original nuclide.

alpha disintegration = alpha decay.

alphanumeric (*alpha*bet plus *numeric*). Including letters and digits.

alpha particle. A positively charged particle

emitted from the nuclei of certain atoms during radioactive disintegration. The alpha particle has an atomic weight of 4 and a positive charge equal in magnitude to 2 electronic charges; hence it is essentially a helium nucleus (helium atom stripped of its two planetary electrons). Compare **beta particle, gamma ray.**

alpha ray. A stream of **alpha particles.**

altimeter. An instrument for measuring height above a reference datum; specifically, an instrument similar to an **aneroid** barometer that utilizes the change of atmospheric pressure with altitude to indicate the approximate elevation above a given point or plane used as a reference. See **absolute altimeter, pressure altimeter, radio altimeter.**

altitude (*symbol* h). **1.** In astronomy, angular displacement above the **horizon;** the arc of a vertical circle between the horizon and a point on the **celestial sphere,** measured upward from the horizon.

Angular displacement below the horizon is called *negative altitude* or *dip.* See **horizon system.**

2. Height, especially radial distance as measured above a given datum, as average sea level. See **absolute altitude, true altitude.**

In space navigation *altitude* designates distance from the mean surface of the reference body as contrasted to *distance,* which designates distance from the center of the reference body.

altitude acclimatization. A physiological adaptation to reduced atmospheric and oxygen pressure.

altitude chamber. A chamber within which the air pressure, temperature, etc., can be adjusted to simulate conditions at different altitudes; used for experimentation and testing.

altitude circle = parallel of altitude.

altitude difference. In navigation, the difference between computed and observed altitudes, or between precomputed and sextant altitudes.

It is labeled T (toward) or A (away) as the observed (or sextant) altitude is greater or smaller than the computed (or precomputed) altitude. Also called *altitude intercept, intercept.*

altitude intercept = altitude difference. Often shortened to *intercept.*

altitude sickness. In general, any sickness brought on by exposure to reduced oxygen tension and barometric pressure.

Many writers have proposed specific definitions for this term but the definitions are highly variable.

altitude wind tunnel. A **wind tunnel** in which the air pressure, temperature, and humidity can be varied to simulate conditions at different altitudes.

In an altitude wind tunnel for testing engines, provision is made for exchanging fresh air for exhaust-laden air during operation.

alveolar air. The respiratory air in the **alveoli** (air sacs) deep within the lungs.

alveolar oxygen pressure. The oxygen pressure in the **alveoli.** The value is about 105 millimeters of mercury.

alveoli. The terminal air sacs deep within the lungs.

The inhaled oxygen diffuses across the thin alveolar membranes (the walls of the air sacs) into the blood stream, and at the same time carbon dioxide diffuses from the blood into the alveoli and is exhaled through the lungs.

AM (*abbr*) = **amplitude modulation.**

ambient (*symbol* a, used as a subscript). Surrounding; especially, of or pertaining to the environment about a flying aircraft or other body but undisturbed or unaffected by it, as in *ambient* air, or *ambient temperature.*

ambient noise. The pervasive **noise** associated with a given environment, being usually a composite of sounds from sources both near and distant.

ambiguity. In navigation, the condition obtaining when a given set of observations defines more than one point, direction, line of position, or surface of position.

American Ephemeris and Nautical Almanac. An annual publication of the U.S. Naval Observatory, containing elaborate tables of the predicted positions of various celestial bodies and other data of use to astronomers and navigators.

Beginning with the editions for 1960, The American Ephemeris and Nautical Almanac issued by the Nautical Almanac Office, United States Naval Observatory, and The Astronomical Ephemeris issued by H. M. Nautical Almanac Office, Royal Greenwich Observatory, were unified. With the exception of a few introductory pages, the two publications are identical; they are printed separately in the two countries, from reproducible material prepared partly in the United States of America and partly in the United Kingdom.

American Nautical Almanac. See **Nautical Almanac.**

ampere (abbr A). The unit of electric current; the constant current which, if maintained in two straight, parallel conductors of infinite length, of negligible circular sections, and placed 1 meter apart in a vacuum will produce between these conductors a force equal to 2×10^{-7} **newtons** per meter of length.

amplidyne. A special type of direct current generator used as a power **amplifier** in which the output voltage responds to changes in field excitation; used extensively in **servo** systems.

amplifier. A device which enables an input signal to control a source of power, and thus is capable of delivering at its output an enlarged

reproduction of the essential characteristics of the signal.

Typical amplifying elements are electron tubes, transistors, and magnetic circuits.

amplitude. **1.** The maximum value of the displacement of a **wave** or other periodic phenomenon from a reference position. **2.** Angular distance north or south of the **prime vertical;** the arc of the horizon, or the angle at the **zenith** between the prime vertical and a **vertical circle,** measured north or south from the prime vertical to the vertical circle.

The term is customarily used only with reference to bodies whose centers are on the celestial horizon, and is prefixed E or W, as the body is rising or setting, respectively; and suffixed N or S to agree with the declination. The prefix indicates the origin, and the suffix indicates the direction of measurement. Amplitude is designated as *true, magnetic, compass,* or *grid* as the reference direction is true, magnetic, compass, or grid east or west, respectively.

amplitude-modulated indicator. One of two general classes of **radar indicators,** in which the sweep of the electron beam is deflected vertically or horizontally from a base line to indicate the existence of an **echo** from a target. The amount of deflection is usually a function of the echo signal strength. Also called *deflection-modulated indicator.* Compare **intensity modulated indicator.**

amplitude modulation. **1.** In general, **modulation** in which the amplitude of a **wave** is the characteristic subject to variation. **2.** Specifically, in telemetry those systems of modulation in which each component frequency f of the transmitted intelligence produces a pair of **sideband** frequencies at carrier frequency plus f and carrier minus f.

In special cases: (**a**) the carrier may be suppressed, (**b**) either the lower or upper sets of sideband frequencies may be suppressed; (**c**) the lower set of sideband frequencies may be produced by one or more channels of information and the upper set of sideband frequencies may be produced by one or more other channels of information; (**d**) the carrier may be transmitted without intelligence carrying sideband frequencies.

AMR = *A*tlantic *M*issile *R*ange.

anacoustic zone. The region above an altitude of about 100 miles where the distance between the air molecules is greater than the wavelength of sound, and sound waves can no longer be propagated.

analog. In computers, pertaining to the use of physical variables such as voltage, distance, rotation, etc. To represent numerical variables as in *analog computer, analog output.* Compare **digital.**

analog computer. A computing machine working on the principle of measuring, as distinguished from counting, in which the input data is analogous to a measurement continuum, such as linear lengths, voltages, resistances, etc., which can be manipulated by the computer.

Analog computers range in complexity from a slide rule to electrical computers used for solving mathematical problems.

analog output. **Transducer** output in which the amplitude is continuously proportional to a function of the stimulus. Distinguished from *digital output.*

analog to digital conversion. A process by which a sample of **analog** information is transformed into a **digital** code.

analog to digital converter (*abbr* **ADC**). A device which will convert an **analog** voltage sample to an equivalent **digital** code of some finite resolution. Also called *digitizer, encoder.*

analytical photography. Photography, either motion picture or still, accomplished to determine (by qualitative, quantitative, or any other means) whether a particular phenomenon does or does not occur. See **technical photography.**

Differs from **metric photography** in that measurements are not a prime requisite.

AND. In **Boolean algebra,** the operation of **intersection.**

And, Andr. International Astronomical Union abbreviations for *Andromeda.* See **constellation.**

AND circuit = AND gate.

AND gate, and gate. A circuit or device used in computers whose output is energized only when every input is in its prescribed state. It performs the logical function of the *AND*, the Boolean operation of **intersection.** Also called *intersector, AND circuit.*

AND-NOT gate = exclusive OR circuit.

Andromeda (*abbr* **And, Andr**). See **constellation.**

aneroid. A thin, disk-shaped box or capsule, usually metallic, partially evacuated of air and sealed, which expands and contracts with changes in atmospheric or gaseous **pressure.**

The aneroid is the sensing and actuating element in various meters or gages, such as barometers, altimeters, manifold-pressure gages, etc; it is also the triggering or operating element in various automatic mechanisms.

A device similar to an aneroid, but open to outside pressures, such as the capsule in an airspeed indicator, is not commonly called an *aneroid.*

angel. A radar **echo** caused by a physical phenomenon not discernible to the eye.

Angels are usually **coherent echoes** and sometimes of great signal strength (up to 40 decibels above the noise level). They have been ascribed to insects flying through the radar beam, but have also been observed under atmospheric conditions which indicate there must be other causes. Studies indicate that a fair portion of them are caused by strong temperature or moisture gra-

dients, or both, such as might be found near the boundaries of bubbles of especially warm or moist air (see **blob**). They frequently occur in shallow layers at or near temperature inversions within the lowest few thousand feet of the atmosphere.

angle. The inclination to each other of two intersecting lines, measured by the arc of a circle intercepted between the two lines forming the angle, the center of the circle being the point of intersection.

An acute angle is less than 90°; a right angle, 90°; an obtuse angle, more than 90° but less than 180°; a straight angle, 180°; a reflex angle, more than 180° but less than 360°; a perigon, 360°. Any angle not a multiple of 90° is an oblique angle. If the sum of two angles is 90°, they are complementary angles; if 180°, supplementary angles; if 360°, explementary angles. Two adjacent angles have a common vertex and lie on opposite sides of a common side. A dihedral angle is the angle between two intersecting planes. A spherical angle is the angle between two intersecting great circles.

angle modulation. **Modulation** in which the angle of a sine-wave **carrier** is the characteristic varied from its normal value.

Phase and **frequency modulation** are particular forms of angle modulation.

angle of arrival. A measure of the direction of propagation of electromagnetic radiation upon arrival at a receiver (most commonly used in radio). It is the angle between the plane of the phase front and some plane of reference, usually the horizontal, at the receiving antenna. This angle is a function of the **index of refraction** gradient of the medium through which the energy is traveling, and the relative positions of the transmitter and receiver. Compare **angle of incidence.**

Angles of arrival can be measured for both the direct and reflected components of a wave using a multiple-antenna receiving system called an *interferometer.*

angle of attack. The angle between a reference line fixed with respect to an **airframe** and a line in the direction of movement of the body.

angle of climb. The angle between the **flight path** of a climbing vehicle and the local horizontal.

angle of depression. The angle in a vertical plane between the local horizontal and a descending line. Also called *depression angle.* See **angle of elevation.**

angle of descent. The angle between the **flight-path** of a descending vehicle and the local horizontal.

angle of deviation. The angle through which a **ray** is bent by **refraction.**

angle of elevation. The angle in a vertical plane between the local horizontal and an ascending line, as from an observer to an object. Also called *elevation angle.*

A negative angle of elevation is usually called an *angle of depression.*

angle of incidence. 1. The angle at which a **ray** of energy impinges upon a surface, usually measured between the direction of propagation of the energy and a perpendicular to the surface at the point of impingement, or incidence. Compare **angle of arrival.** See also **angle of reflection, angle of refraction.**

In some cases involving radio waves, the angle of incidence is measured relative to the surface.

2. = **angle of attack.** (British usage).

angle of minimum deviation. See **minimum deviation.**

angle of pitch. 1. The angle, as seen from the side, between the longitudinal **body axis** of an aircraft or similar body and a chosen reference line or plane, usually the horizontal plane. This angle is positive when the forward part of the longitudinal axis is directed above the reference line. 2. Same as **blade angle** (in all senses).

angle of reflection. The angle at which a reflected ray of energy leaves a reflecting surface, measured between the direction of the outgoing ray and a perpendicular to the surface at the point of reflection. Compare **angle of incidence.**

In some cases involving radio waves, the angle of reflection is measured relative to the surface.

angle of refraction. The angle at which a refracted **ray** of energy leaves the interface at which the **refraction** occurred, measured between the direction of the refracted ray and a perpendicular to the **interface** at the point of refraction.

angle of roll. The angle that the lateral body axis of an aircraft or similar body makes with a chosen reference plane in rolling; usually, the angle between the lateral axis and a horizontal plane. The angle of roll is considered positive if the roll is to starboard.

angle of yaw. The angle, as seen from above, between the longitudinal **body axis** of an aircraft, rocket, or the like and a chosen reference direction. This angle is positive when the forward part of the longitudinal axis is directed to starboard. Also called *yaw angle.*

angstrom (*abbr* **A, Å**). A unit of length, used chiefly in expressing short wavelengths. It equals 10^{-10} meters or 10^{-8} centimeters.

Ångström compensation pyrheliometer. An instrument developed by K. Ångström for the measurement of **direct solar radiation.** The radiation receiver station consists of two identical manganin strips whose temperatures are

measured by attached thermocouples. One of the strips is shaded, whereas the other is exposed to sunlight. An electrical heating current is passed through the shaded strip so as to raise its temperature to that of the exposed strip. The electric power required to accomplish this is a measure of the solar radiation. See **actinometer, pyrheliometer.** Compare **Ångström pyrgeometer.**

Ångström pyrgeometer. An instrument developed by K. Ångström for measuring the **effective terrestrial radiation.** It consists of four manganin strips, of which two are blackened and two are polished. The blackened strips are allowed to radiate to the atmosphere while the polished strips are shielded. The electrical power required to equalize the temperature of the four strips is taken as a measure of the outgoing radiation. See **actinometer, pyrgeometer.** Compare **Ångström compensation pyrheliometer.**

angular acceleration (*symbol* α). The rate of change of **angular velocity.**

angular distance. **1.** The angular difference between two directions, numerically equal to the angle between two lines extending in the given directions. **2.** The arc of the **great circle** joining two points, expressed in angular units. **3.** Distance between two points, expressed in **wave lengths** at a specified **frequency.**

It is equal to the number of waves between the points multiplied by 2π if expressed in radians, or multiplied by 360° if measured in degrees.

angular frequency (*symbol* ω). The **frequency** of a periodic quantity expressed in radians per second. It is equal to the frequency in cycles per second multiplied by 2π. Also called *circular frequency.*

angular rate = angular speed, sense **1.**

angular resolution. Specifically, the ability of a radar to distinguish between two targets solely by the measurement of angles.

It is generally expressed in terms of the minimum angle by which targets must be spaced to be separately distinguishable. See **resolution.**

angular speed. **1.** Change of direction per unit time, as of a target on a radar screen. Also called *angular rate.* **2.** = **angular velocity.**

angular velocity (*symbol* ω). The change of angle per unit time; specifically, in celestial mechanics, the change in angle of the **radius vector** per unit time.

anisotropic. Exhibiting different properties when tested along axes in different directions.

annealing. Application of heat energy to a material cooling at a suitable rate to: relieve stresses, change certain properties, improve machinability, etc., or for realignment of atoms in a distorted crystal lattice as caused, for example, by radiation damage.

annual parallax. See **parallax.**

annular. Pertaining to an annulus or ring; ring shaped.

annular eclipse. An **eclipse** in which a thin ring of the source of light appears around the obscuring body.

anode. The positive pole or **electrode** of any electron emitter, such as an electron tube or an electric cell.

The negative pole or electrode is called a *cathode.*

anomalistic month. The average period of revolution of the moon from **perigee** to perigee, a period of 27 days 13 hours 18 minutes 33.2 seconds.

anomalistic period. The interval between two successive **perigee** passages of a **satellite** in orbit about a primary. Also called *perigee-to-perigee period.*

anomalistic year. The period of one revolution of the earth about the sun from **perihelion** to perhihelion; 365 days 6 hours 13 minutes 53.0 seconds in 1900 and increasing at the rate of 0.26 second per century.

anomalous dispersion. **Dispersion** of electromagnetic radiation characterized by a decrease in **refractive index** with increase in **frequency.**

anomalous propagation. The propagation of energy when it arrives at a destination via a path significantly different from the normally expected path.

The term is usually applied to the transmission of various forms of energy through the atmosphere when, in addition to the line-of-sight path, the energy is refracted by density discontinuities at one or more levels in the atmosphere. Therefore, it propagates to a point that could not be reached via a line-of-sight path. In radio and radar studies, it refers to the abnormal **refraction** of a beam of radio energy, usually applied to **superstandard propagation** rather than to **substandard propagation.** In either case, anomalous propagation results from an unusual vertical distribution of temperature and moisture in the atmosphere.

The anomalous propagation of sound refers to the downward refraction of an oblique sound wave from an explosion, the refraction occurring in the region of increasing temperature with height in the lower mesosphere. The anomalous propagation of sound has been used as a method for determining upper air temperatures and winds.

anomaly. **1.** In general, a deviation from the norm. **2.** In geodesy, a deviation of an observed value from a theoretical value, due to an abnormality in the observed quantity. **3.** In

celestial mechanics, the angle between the **radius vector** to an orbiting body from its primary (the focus of the orbital ellipse) and the **line of apsides** of the orbit, measured in the direction of travel, from the point of closest approach to the primary (perifocus).

The term defined above is usually called *true anomaly* v to distinguish it from the eccentric anomaly E which is measured at the center of the orbital ellipse to the projection of the body onto the auxiliary circle of the ellipse, or from the mean anomaly M which is what the true anomaly would become if the orbiting body had a uniform angular motion.

The mean anomaly M can be computed by

$$M = n\ (t - T)$$

where n is mean motion; t is time of the computation; and T is time of perifocus.

The eccentric anomaly E and the mean anomaly M are related by the Kepler equation

$$M = E - e \sin E$$

where e is eccentricity of the ellipse.

From E, the true anomaly v can be obtained by

$$\tan v/2 = [(1 + e)/(1 - e)]1/2 \tan E/2$$

anoxaemia = hypoxaemia.

anoxia. A complete lack of oxygen available for physiological use within the body. Compare **hypoxia.**

Anoxia is popularly used as a synonym for *hypoxia*. This usage should be avoided.

Ant, Antl. International Astronomical Union abbreviations for *Antlia*. See **constellation.**

antapex. See **solar apex.**

antenna. A conductor or system of conductors for radiating or receiving **radio waves.**

antenna array. A system of **antennas** coupled together to obtain directional effects, or to increase sensitivity.

antenna effect. A weakening of the effectiveness of the directional properties of a **loop antenna** by the capacitance of the loop to the ground. Also called *height effect.*

In usual direction-finding practice on ground waves, antenna effect would be manifested: (**a**) if in phase, by an angular displacement of the nulls from 180° displacement and (**b**), if in quadrature, by a residual signal obscuring the nulls. The in-phase effect is often used to eliminate the 180° ambiguity (i.e., to permit sense finding).

antenna field. A group of **antennas** placed in a geometric configuration.

antenna gain. See **gain,** sense **2(a).**

antenna null. See **null.**

antenna pair. Two **antennas** located on a **base line** of accurately surveyed length.

antenna pattern = radiation pattern.

antenna temperature. In radio astronomy, a measure of the power absorbed by the **antenna.**

In an ideal, loss-free radio telescope, the antenna temperature is equal to the **brightness temperature** if the intensity of the received radiation is constant within the main lobe. If the angular dimension of the source is small compared to the main lobe, the antenna temperature is equal to the brightness temperature multiplied by the ratio of the solid angle subtended by the source to the effective solid angle of the antenna.

anticyclonic. Having a sense of rotation about the local vertical opposite to the rotation of the earth; that is, clockwise in the northern hemisphere, counterclockwise in the southern hemisphere, undefined at the equator; the opposite of **cyclonic.**

antigravity. A hypothetical effect that would arise from cancellation by some energy field of the effect of the **central force field** of the earth or other body.

Antigravity is common in science fiction but has not yet been reported in scientific literature.

anti-g suit = g-suit.

anti-matter. Matter consisting of **anti-particles.**

antinode. **1.** Either of the two points on an **orbit** where a line in the orbit plane, perpendicular to the **line of nodes,** and passing through the **focus,** intersects the orbit. **2.** A point, line, or surface in a standing wave where some characteristic of the wave field has maximum amplitude. Also called *loop.*

In sense 2, the appropriate modifier should be used before the word *antinode* to signify the type that is intended; e.g., *displacement* antinode, *velocity* antinode, *pressure* antinode.

anti-particle. Any **particle** with a charge of opposite sign to the same particle in normal matters.

Thus, the **proton** has a positive charge; the **anti-proton,** a negative charge. When a particle and its **anti-particle** collide, both may disappear with the creation of lighter particles; this process is called *annihilation.*

antipode. Anything exactly opposite to something else. Particularly, that point on the earth 180° from a given place.

antiresonance. For a system in **forced oscillation,** the condition existing at a point when any change, however small, in the frequency of excitation causes an increase in the response at this point.

antisolar point. That point on the **celestial sphere** 180° from the sun.

Antlia (*abbr* **Ant, Antl**). See **constellation.**

apareon. The point on a Mars-centered **orbit** where a satellite is at its greatest distance from Mars.

Apareon is analagous to *apogee*. See **geo.**

apastron. That point of the **orbit** of one member of a **binary star** system at which the stars are farthest apart. That point at which they are closest together is called *periastron.*

aperiodic. Without a period; not cyclic; completely **damped.**

aperture. 1. An opening; particularly, that opening in the front of a camera through which light rays pass when a picture is taken. 2. The diameter of the **objective** of a telescope or other optical instrument, usually expressed in inches, but sometimes as the angle between lines from the principal focus to opposite ends of a diameter of the objective. 3. Of a unidirectional **antenna,** that portion of a plane surface near the antenna, perpendicular to the direction of maximum radiation, through which the major part of the radiation passes. See **effective area.**

aperture ratio. The ratio of the useful diameter of a lens to its focal length. It is the reciprocal of the **f-number.**

In application to an optical instrument, rather than to a lens, *numerical aperture* is more commonly used. The aperture ratio is then twice the tangent of the angle whose sine is the numerical aperture.

apex of the sun's motion = **solar apex.**

apex of the sun's way = **solar apex.**

aphelion. That point in a solar **orbit** which is most distant from the sun.

The point nearest the sun is called *perihelion.*

apoapsis. That point in an orbit farthest from the center of attraction.

apocenter = **apofocus.**

apocynthion. That point in the **orbit** of a moon satellite which is farthest from the moon.

apofocus. The point on an **elliptic orbit** at the greatest distance from the principal **focus.**

apogee. 1. That point in a **geocentric orbit** which is most distant from the earth. That orbital point nearest the earth is called *perigee.* See **geo.**

By extension, *apogee* and *perigee* are also used in reference to orbits about other planets and natural satellites.

2. Of a satellite or rocket: To reach its apogee (sense 1), as in *the Vanguard apogees at 2,560 miles.*

apostilb. A unit of **luminance** equal to $1/\pi \times 10^{-4}$ international candles per square centimeter. Compare **stilb.**

apparent. In astronomy, observed.

True values are reduced from *apparent* (observed) values by eliminating those factors such as refraction, light time, etc., which affected the observation.

apparent additional mass. A fictitious **mass of fluid** added to the mass of the body to represent the force required to accelerate the body through the fluid.

The apparent additional mass has *inertia* and *momentum* equal to the apparent increase of the inertia and momentum of the body.

apparent force. A **force** introduced in a **relative coordinate system** in order that **Newton laws** be satisfied in this system. This force must be equal and opposite to an acceleration in an **inertial coordinate system,** in which Newton laws are (by definition) satisfied. Examples are the coriolis force, and the centrifugal force incorporated in gravity.

apparent gravity = **acceleration of gravity.**

apparent horizon. See **horizon.**

apparent motion. Motion relative to a specified or implied reference point which may itself be in motion. Also called *relative motion.* See **relative movement.**

In astronomy *apparent motion* usually refers to movement of celestial bodies as observed from the earth.

apparent position. The position on the **celestial sphere** at which a heavenly body (or a space vehicle) would be seen from the center of the earth at a particular time. Compare **astrometric position.**

The apparent position of a body is displaced from the true position at the time of observation by the motion of the body during the time it takes light to travel from the body to the earth (see **planetary aberration**) and by **aberration.**

Most ephemerides tabulate apparent position of the sun, moon, and planets.

apparent solar day. The duration of one rotation of the earth on its axis, with respect to the **apparent sun.** It is measured by successive transits of the apparent sun over the lower branch of a meridian. The length of the apparent solar day is 24 hours of apparent time and averages the length of the **mean solar day,** but varies somewhat from day to day.

apparent solar time. See **solar time.**

apparent stresses = **Reynolds stresses.**

apparent sun. The actual sun as it appears in the sky. Also called *true sun.* See **mean sun, dynamical mean sun.**

apparent time. Time based upon the rotation of the earth relative to the **apparent** or **true sun.** This is the time shown by a sundial. See **equation of time.**

Apparent time may be designated as either local or Greenwich, as the local or Greenwich meridian is used as the reference.

apparent wander. Apparent change in the direction of the axis of rotation of a spinning body, as a gyro, due to rotation of the earth. Often shortened to *wander.* See **precession.**

The horizontal component of apparent wander is called *drift,* and the vertical component is called *topple.*

Appleton layer = **F_2-layer.** See **ionosphere.**

approximate absolute temperature scale (*abbr* **AA**). A temperature scale with the ice point at

273° and boiling point of water at 373°. It is intended to approximate the Kelvin temperature scale with sufficient accuracy for many sciences, notably meteorology, and is widely used in the meteorological literature. Also called *tercentesimal thermometric scale.*

appulse. **1.** The near approach of one celestial body to another on the **celestial sphere,** as in **occultation, conjunction,** etc. **2.** A **penumbral eclipse** of the moon.

apron. Specifically, a protective device specially designed to cover an area surrounding the fuel inlet on a **rocket** or **spacecraft.**

Aps, Apus. International Astronomical Union abbreviations for *Apus.* See **constellation.**

apse = apsis.

apsides. Plural of **apsis.**

apsis (*plural* **apsides**). In celestial mechanics, either of the two orbital points nearest or farthest from the center of attraction. Also called *apse.*

The apsides are the **perihelion** and **aphelion** in the case of an orbit about the sun, and the **perigee** and **apogee** in the case of an orbit about the earth. The line connecting these two points is called *line of apsides.* The nearest point is the lower apsis while the farthest point is the higher apsis.

APU (*abbr*) = ***auxiliary power unit.***

Aql, Aqil. International Astronomical Union abbreviations for *Aquila.* See **constellation.**

Aquarius (*abbr* **Aqr, Aqar**). See **constellation.**

aqueous vapor = water vapor.

Aquila (*abbr* **Aql, Aqil**). See **constellation.**

Ara (*abbr* **Ara, Arae**). See **constellation.**

Arago point. One of the three commonly detectable points along the vertical circle through the sun at which the degree of polarization of **diffuse sky radiation** goes to zero; a neutral point.

The Arago point, so named for its discoverer, is customarily located at about 20° above the antisolar point; but it lies at higher altitudes in turbid air. The latter property makes the Arago distance a useful measure of atmospheric turbidity.

arc. **1.** A part of a curved line, as a circle. **2.** A luminous glow which appears when an electric current passes through ionized air or gas. **3.** An auroral arc. See **aurora.** See **arc discharge.**

arc discharge. A luminous, gaseous, electrical discharge in which the charge transfer occurs continuously along a narrow channel of high **ion density.** An arc discharge requires a continuous source of electric potential difference across the terminals of the arc.

Arc discharge is to be distinguished from **corona discharge, point discharge,** and **spark discharge.**

arc spectrum. The **spectrum** of a neutral atom, designated by the Roman numeral I following the symbol for the element, as He I. See **spark spectrum.**

arcs with ray structure. See **aurora.**

arctic blackout = blackout.

ARDC model atmosphere. See **standard atmosphere.**

areal radiant intensity = steradiancy.

areal velocity. In celestial mechanics, the area swept out by the **radius vector** per unit time.

The areal velocity is constant for a central force. See **Kepler laws.**

area rule. A prescribed method of design for obtaining minimum zero-lift **drag** for a given aerodynamic configuration, such as a wing-body configuration, at a given speed.

For a transonic body, the area rule is applied by subtracting from, or adding to, its cross-sectional area distribution normal to the airstream at various stations so as to make its cross-sectional area distribution approach that of an ideal body of minimum drag; for a supersonic body, the sectional areas are frontal projections of areas intercepted by planes inclined at the Mach angle.

areo. Combining form of Mars (Ares), as in *areography.*

Words formed with *areo* are considered pedantic by some. See **geo.**

areocentric. With Mars as a center.

Areocentric is analogous to *geocentric.* See **geo.**

areographic. Referring to positions on Mars measured in latitude from Mars' equator and in longitude from a reference meridian.

areography. The study of the surface features of Mars; the geography of Mars.

Ares. Mars.

Ares is seldom used except in combining forms as *areocentric, apareon.*

Arg. International Astronomical Union abbreviation for *Argo.* See **constellation.**

Argo (*abbr* **Arg**). See **constellation.**

argument. In astronomy, an angle or arc, as in *argument of perigee.*

argument of latitude. In celestial mechanics, the **angular distance** measured in the **orbit plane** from the **ascending node** to the orbiting object; the sum of the argument of perigee and the true **anomaly.**

argument of perigee (*symbol* ω). In celestial mechanics, the angle or arc, as seen from a **focus** of an elliptical **orbit,** from the **ascending node** to the closest approach of the orbiting body to the focus. The angle is measured in the orbital plane in the direction of motion of the orbiting body.

Ari, Arie. International Astronomical Union abbreviations for *Aries.* See **constellation.**

Ariel. A satellite of Uranus orbiting at a mean distance of 192,000 kilometers.

Aries (*abbr* **Ari, Arie**). See **constellation.**

arithmetic element = **arithmetic unit.**

arithmetic mean. One of several accepted measures of central tendency, physically analogous to *center of gravity.* Pertaining to a set of numbers $x_1, x_2, \ldots x_n$, the arithmetic mean, usually denoted by the symbol $\bar{x}$, is the sum $x_1 + x_2 + \ldots + x_n$ divided by n. Also called *mean, average, simple average.*

Since the word *mean* is also applied to other measures of central tendency, such as weighted means, geometric means, harmonic means, the adjective *arithmetic* is used for clarity. However, when used without further qualification, the term *mean* is understood as *arithmetic mean.*

arithmetic unit. That part of a **computer** which performs arithmetic operations. Also called *arithmetic element.*

array = **antenna array.**

arrhythmia. Absence of rhythm, as, for example, in heart beat.

arrow wing. An aircraft wing of V-shaped planform, either tapering or of constant chord, suggesting a stylized arrowhead.

artificial antenna. A device which has the equivalent impedance characteristics of an **antenna** and the necessary power-handling capabilities, but which does not radiate nor intercept radiofrequency energy. Also called *dummy antenna.*

artificial asteroid. A manmade object placed in orbit about the sun. See **asteroid.**

artificial earth satellite. A manmade earth **satellite,** as distinguished from the moon.

artificial feel. A **control feel** simulated by mechanisms incorporated in the control system of an aircraft or spacecraft where the forces acting on the control surfaces are not transmitted to the cockpit controls, as in the case of an irreversible control system or a power-boosted system.

artificial gravity. A simulated **gravity** established within a space vehicle by rotation or acceleration.

artificial horizon. 1. A gyro-operated flight instrument that shows the pitching and banking attitudes of an aircraft or spacecraft with respect to a reference line horizon, within limited degrees of movement, by means of the relative position of lines or marks on the face of the instrument representing the aircraft and the **horizon.** See **attitude gyro. 2.** A device, such as a spirit level, pendulum, etc., that establishes a horizontal reference in a navigation instrument.

artificial satellite. A manmade **satellite.**

A-scan = **A-display.**

ascendent. The negative of the **gradient.** The ascendent of a function is a vector with magnitude equal to the maximum spatial rate of change of that function at a given point at a given time.

It is directed toward increasing values of the function along the line of maximum change, and is represented by ∇F, where F is the function and ∇ the del-operator.

ascending node. That point at which a planet, planetoid, or comet crosses to the north side of the **ecliptic**; that point at which a **satellite** crosses to the north side of the equatorial plane of its primary. Also called *northbound node.* The opposite is *descending node* or *southbound node.*

A-scope = **A-display.**

asdic. British term for *sonar.*

Askania (a trade name) = **cine-theodolite.**

aspect ratio. The ratio of the square of the **span** of an **airfoil** to the total airfoil area, or the ratio of its span to its mean **chord.**

An airfoil of high aspect ratio is of relatively long span and short chord; one of low aspect ratio is of relatively short span and long chord.

aspects. The **apparent positions** of celestial bodies relative to one another; particularly, the apparent positions of the moon or a planet relative to the sun.

aspiration condenser. An **ion counter** collecting element consisting of a cylindrical condenser which when charged produces a radial field which collects ions from the aspirated air.

assemble. In computer terminology, to organize the **subroutines** into a complete **program.**

assisted take-off. A take-off of an aircraft using a supplementary source of power, usually rockets. See **RATO.**

associated corpuscular emission. The full complement of secondary charged **particles** (usually limited to electrons) associated with an **X-ray** or **gamma-ray** beam in its passage through matter.

The full complement of electrons is obtained after the radiation has traversed sufficient matter to bring about equilibrium between the primary photons and secondary electrons. Electronic equilibrium with the secondary photons is intentionally excluded.

assumed latitude. See **latitude.**

assumed longitude. See **longitude.**

A-station. In **loran,** the designation applied to the transmitting station of a pair, the signal of which always occurs less than half a repetition period after the next preceding signal and more than half a repetition period before the next succeeding signal of the other station of the pair, designated a *B-station.*

asteroid. One of the many small celestial bodies revolving around the sun, most of the orbits being between those of Mars and Jupiter. Also called *planetoid*, *minor planet*. See **planet.**

The term *minor planet* is preferred by many astronomers but *asteroid* continues to be used in astronomical literature, especially attributively, as in *asteroid belt*.

All asteroids with determined orbits (except for a few discovered during World War II) are numbered for identification in the order of their discovery. *The Ephemerides of the Minor Planets* published by the U.S.S.R. Academy of Sciences lists all numbered asteroids, data concerning them, and their predicted positions. The daily positions of the first four minor planets are tabulated in the *American Ephemeris and Nautical Almanac*. Orbits have been determined for approximately 1700 asteroids.

Asteroids have names as well as numbers, see table I. The names are usually feminine but masculine names have been used for asteroids closer to or farther away from the Sun than the majority. The first asteroid to be given a masculine name, Eros (number 443) was the first to be discovered inside the orbit of Mars. The Trojan asteroids, named for heroes of the Trojan war, are in the orbit of Jupiter.

TABLE I.—ASTEROIDS

	Number	Name	Mean distance from Sun, AU
The first 20 asteroids discovered	1	Ceres	2.8
	2	Pallas	2.8
	3	Juno	2.7
	4	Vesta	2.4
	5	Astraea	2.6
	6	Hebe	2.4
	7	Iris	2.4
	8	Flora	2.2
	9	Metis	2.4
	10	Hygiea	3.1
	11	Parthenope	2.4
	12	Victoria	2.3
	13	Egeria	2.6
	14	Irene	2.6
	15	Eunomia	2.6
	16	Psyche	2.9
	17	Thetis	2.5
	18	Melpomene	2.3
	19	Fortuna	2.4
	20	Massalia	2.4
Close asteroids	433	Eros	1.5
	1566	Icarus	1.1
	1620	Geographos	1.2
		Apollo	1.5
		Hermes	1.3
Trojan asteroids (all in Jupiter's orbit)	588	Achilles	5.2
	617	Patroclus	
	624	Hector	
	659	Nestor	
	884	Priamus	
	911	Agamemnon	
	1143	Odysseus	
	1172	Aeneas	
	1173	Anchises	
	1208	Troilus	
	1404	Ajax	
	1437	Diomedes	
	1583	Antiochus	
	1647	Menelaus	

astral dome = astrodome.

astre fictif. A point on the **celestial sphere** used as a reference in measuring time intervals. See **day.**

astro. A prefix meaning *star* or *stars* and, by extension, sometimes used as the equivalent of *celestial*, as in *astro*nautics.

astroballistics. The study of the phenomena arising out of the motion of a solid through a gas at speeds high enough to cause **ablation;** for example, the interaction of a meteoroid with the atmosphere.

Astroballistics uses the data and methods of astronomy, aerodynamics, ballistics, and physical chemistry.

astrobiology. The study of living organisms on celestial bodies other than the earth.

astrocompass. An instrument used to determine direction by sighting heavenly bodies of known position.

astrodome. A transparent dome in the fuselage or body of an aircraft or spacecraft intended primarily to permit taking **celestial observations** in navigating. Also called a *navigation dome, astral dome.*

astrodynamics. The practical application of **celestial mechanics, astroballistics,** propulsion theory, and allied fields to the problem of planning and directing the **trajectories** of space vehicles.

Astrodynamics is sometimes used as a synonym for *celestial mechanics*. This usage should be discouraged.

astrogation. Contraction of *astronavigation.*

astrographic position = astrometric position.

astrolabe. 1. In general, any instrument designed to measure the **altitudes** of celestial bodies. **2.** Specifically, an instrument designed for very accurate celestial altitude measurements, as in survey work.

astrometric position. The position of a heavenly body (or space vehicle) on the **celestial sphere** corrected for **aberration** but not for **planetary aberration.** Compare **apparent position.**

Astrometric positions are used in photographic observations where the position of the observed body can be measured in reference to the positions of comparison stars in the field of the photograph.

TABLE II.—SOME CONSTANTS OF CONVENTIONAL (C) AND REVISED (R) SYSTEMS OF ASTRONOMICAL CONSTANTS[a]

Constant	Symbol	System[a]	Value[b]
Equatorial radius of Earth	a	C	6,378,388 m
		R[c]	6,378,160 m
Flattening of Earth	f	C	1/297
		R	1/298.25 = 0.0033529
Polar radius of Earth	$a(1-f)$	C	6,356,911.946 m
Normal gravity	g	C	$978.049(1 + 0.0052884 \sin^2 \phi - 0.0000059 \sin^2 2\phi)$ cm/sec²
Solar parallax	π	C	8″.80
		R	8″.79405 or 8″.794[d]
Constant of nutation, 1900.0	N	C	9″.21
		R[c]	9″.210
Constant of aberration	k	C	20″.47
		R	20″.4958 or 20″.496[d]
General precession in longitude per tropical century	p	C	5025″.64 + 2″.22T
		R[c]	5025″.64
Precession in right ascension per tropical century	m	C	4608″.50 + 2″.79T
Precession in declination per tropical century	n	C	2004″.68 − 0″.85T
Speed of rotation of the ecliptic per tropical century	π	C	47″.11 − 0.07T
Longitude of axis of rotation of the ecliptic	Π	C	173° 57′ 03″.6 + 3286″.2T
Obliquity of the ecliptic	ϵ	C	23° 27′ 08″.26 − 46″.845T − 0″.0059T^2 + 0″.0081T^3
		R[c]	23° 27′ 08″.26 for 1900
Equatorial horizontal parallax of the Moon at distance 60.2665 equatorial radii of Earth		C	57′ 02″.70
Velocity of light	c	C	299,860 km/sec = 186,324 statute miles/sec
		R[c]	299,792.5 km/sec
Time required for light to travel unit distance		R	499″.012 = 1 sec/0.0020396
Calculated from solar parallax		C	498″.580
Calculated from constant of aberration		C	498″.38
Gaussian constant of gravitation	k	C	0.017202098950000 = 3548″.1876069651
		R[c]	0.01720209893
Number of ephemeris seconds in 1 tropical year (1900)		R[c]	31,556,925.9747
Measure of 1 AU	A	R[c]	$149{,}600 \times 10^6$
Dynamical form factor for Earth	J_2	R[c]	0.0010827
Geocentric gravitational constant	GE	R[c]	$398{,}603 \times 10^9$ m³/sec²
Sidereal mean motion of Moon (1900)	n_c^*	R[c]	$2.661699489 \times 10^{-6}$ radius/sec
Heliocentric gravitational constant, $A^3k'^2$	GS	R	$132{,}718 \times 10^{18}$ m³/sec²
Perturbed mean distance of Moon, $F_2[GE(1+\mu)/n_c^{*2}]^{1/3}$	a_c	R	$384{,}400 \times 10^3$ m
Constant of sine parallax for Moon, a_e/a_c	$\sin \pi_c$	R	3,422″.451
Constant for lunar inequality, $[\mu/(1 \times \mu)]\,(a_c/A)$	L	R	6″.43987 or 6″.440[e]

TABLE II.—SOME CONSTANTS OF CONVENTIONAL (C) AND REVISED (R) SYSTEMS OF ASTRONOMICAL CONSTANTS[a] (*Cont.*)

Constant	Symbol	System[a]	Value[b]
Constant for parallactic inequality, $F^3[(1-\mu)/(1+\mu)](a_c/A)$	P_c	R	124″.986
Planetary mass ratios			
Earth to Moon		C	81.45 (for lunar inequality) and 81.53 (by Brown's theory)
		R	81.30
Sun to			
Earth plus Moon		C	329,390
		R	328,912
Earth		R	332,958
Mercury		R	6,000,000
Venus		R	408,000
Mars		R	3,093,500
Jupiter		R	1,047.355
Saturn		R	3,501.6
Uranus		R	22,869
Neptune		R	19,314
Pluto		R	360,000

[a] C: system recommended for continued use by the International Astronomical Union in 1952.
R: system adopted by the 1964 IASU and recommended for introduction into almanacs by 1968.
[b] ϕ: latitude.
T: centuries from 1900.0.
[c] Defining constant.
[d] Rounded value should be used except where extra figures are required to insure numerical consistency.

astrometry. The branch of **astronomy** dealing with the geometrical relations of the celestial bodies and their real and **apparent motions.**

The techniques of astrometry, especially the determination of accurate position by photographic means, are used in tracking satellites and space probes.

astronaut. **1.** A person who rides in a space vehicle. **2.** Specifically, one of the test pilots selected to participate in Project Mercury, Project Gemini, Project Apollo, or any other United States program for manned space flight.

astronautic centrifuge. See **centrifuge.**

astronautics. **1.** The art, skill, or activity of operating **spacecraft.** **2.** In a broader sense the science of space flight.

astronavigation. The plotting and directing of the movement of a **spacecraft** from within the craft by means of observations on celestial bodies. Sometimes contracted to *astrogation* or called *celestial navigation.*

astron machine. An experimental thermonuclear device where a magnetic field is generated by a **relativistic** ring of electrons and shaped into a **magnetic mirror** configuration. The hot electrons serve as a heat source to heat the ions.

astronomic = astronomical.

In any combination, such as *astronomic coordinates, astronomic* is equivalent to *astronomical.*

astronomical. Of or pertaining to **astronomy** or to observations of the celestial bodies. Also called *astronomic.*

Astronomers have long preferred *astronomical.* Geodesists usually use *astronomic* as an intended parallel to *geodetic.* The Coast and Geodetic Survey uses *astronomic* in their publications insofar as is compatible with established practice.

astronomical constants. **1.** The elements of the orbits of the bodies of the solar system, their masses relative to the sun, their size, shape, orientation, rotation, and inner constitution, and the velocity of light. **2. = system of astronomical constants.**

The astronomical constants used in the calculations of *The American Ephemeris and Nautical Almanac,* as well as other national ephemerides, were adopted at various times between 1896 and 1930. Although the system was known to contain many inconsistencies, the International Astronomical Union recommended their continued use in 1952. Space-related research has provided data for the computation of a more accurate system, and in January 1964 The Working Group on the System of Astronomical Constants recommended a new system of constants to be introduced into the national and international ephemerides at the earliest practicable date. Both the conventional and revised systems are given in table II.

The constants in table III were recommended for use in trajectory calculations for NASA programs by the *Ad Hoc* NASA Standards Constants Committee May 16, 1963.

TABLE III.—CONSTANTS RECOMMENDED FOR USE IN TRAJECTORY CALCULATIONS FOR NASA PROGRAMS

Earth Constants

1. Potential function

$$\phi(R, \phi) = \frac{GM_E}{R}\left[1 + \frac{JR_E^2}{3R^2}(1 - 3\sin^2\phi) + \frac{H}{5}\frac{R_E^3}{R^3}(3 - 5\sin^2\phi)\sin\phi + \frac{D}{35}\frac{R_E^4}{R^4}(3 - 30\sin^2\phi + 35\sin^4\phi)\right]$$

where

$GM_E = 3.986032\ (\pm 0.000030) \times 10^5$ km³/sec²
G = gravitational constant
M_E = mass of Earth
R_E = equatorial Earth radius
= 6378.166 (±0.025) km
R = geocentric radius
ϕ = geocentric latitude
$J = 1.62345\ (\pm 0.00030) \times 10^{-3}$
$H = -0.575\ (\pm 0.025) \times 10^{-5}$
$D = 0.7875\ (\pm 0.0875) \times 10^{-5}$

The geometric model of the Earth to be used is the DOD World Geodetic System (1960) also known as the Astrogeodetic World Datum. In this model flattening f and gravity g_e are consistent with GM_E, J and R_E used in the potential function given above

$f = 1/298.3$ $\quad g_e = 0.00978030$ km/sec²

2. Rotation rate, $\omega_E = 360/(86{,}164.09892 + 0.00164T)$ deg/sec where T is the number of Julian centuries of 36 525 days from 1900 Jan 0.5 UT (Julian date = 2,415,020. 0)

Lunar Constants

3. Earth-Moon mass ratio, $M_E/M_M = 81.3015 \pm 0.0033$
4. GM of Moon, GM_M = 4,902.7779 km³/sec²
5. Mean lunar radius, R_M = 1,738.09 km
6. Moments of inertia of Moon about principal axes
   A = 0.887825×10^{35} kg-m²
   B = 0.888005×10^{35} kg-m²
   C = 0.888375×10^{35} kg-m²
7. Constant to convert lunar ephemeris earth radii to kilometers = 6,378.3255

Planetary Constants

8. Astronomical unit = 149.599000×10^6 km
9. Velocity of light = 299,792.5 km/sec

Planet	Mass ratio M_S/M_{planet}	Gravitational constant GM_p, AU³/day²	Gravitational constant GM^p, km³/sec²
Sun	1	$2.959122083 \times 10^{-4}$	$1.32715445 \times 10^{11}$
Mercury	6,120,000	4.835167×10^{-11}	2.168553×10^{4}
Venus	408,645	7.241303×10^{-10}	3.247695×10^{5}
Earth	332,951.3	8.887552×10^{-10}	3.986032×10^{5}
Mars	3,088,000	9.582649×10^{-11}	4.297780×10^{4}
Jupiter	1,047.39	2.825234×10^{-7}	1.267106×10^{8}
Saturn	3,500	8.454635×10^{-8}	3.791870×10^{7}
Uranus	22,869	1.293945×10^{-8}	5.803292×10^{6}
Neptune	18,889	1.566585×10^{-8}	7.026072×10^{6}
Pluto	400,000	7.397805×10^{-10}	3.317886×10^{5}

astronomical coordinates. Coordinates defining a point on the surface of the earth, or of the **geoid,** in which the local direction of gravity is used as a reference. Sometimes called *geographic coordinates,* which see. See **astronomical equator, astronomical latitude, astronomical longitude.**

astronomical day. A **mean solar day** beginning at mean noon, 12 hours later than the beginning of the civil day of the same date. Astronomers now generally use the civil day. See **Julian day, astronomical time.**

astronomical equator. A line on the surface of the earth connecting points having 0° **astronomical latitude.** Sometimes called *terrestrial equator.*

When the astronomical equator is corrected for station error, it becomes the *geodetic equator.*

astronomical latitude. Angular distance between the direction of gravity and the plane of the **celestial equator.** Sometimes called *geographic latitude.*

Astronomical latitude corrected for the *meridional* component of station error becomes *geodetic latitude.*

astronomical longitude. The angle between the plane of the reference meridian and the plane of the **celestial meridian.** Sometimes called *geographic longitude.*

Astronomical longitude corrected for the prime-vertical component of station error divided by the cosine of the latitude becomes *geodetic longitude.*

astronomical meridian. A line connecting points having the same **astronomical longitude.** Also called *terrestrial meridian.*

Because the deflection of the vertical varies from point to point, the astronomical meridian is an irregular line. When the astronomical meridian is corrected for station error, it becomes the *geodetic meridian.*

astronomical parallel. A line connecting points having the same **astronomical latitude.**

Because the deflection of the vertical varies from point to point, the astronomical parallel is an irregular line. When the astronomical parallel is corrected for station error, it becomes the *geodetic parallel.*

astronomical position. **1.** A point on the earth whose coordinates have been determined as a result of observation of celestial bodies.

The expression is usually used in connection with positions on land determined with great accuracy for **survey** purposes.

2. A point on the earth, defined in terms of **astronomical latitude** and **longitude.**

astronomical refraction. **1.** The angular difference between the apparent **zenith distance** of a celestial body and its true zenith distance, produced by **refraction** effects as the light from the body penetrates the atmosphere. Also called *atmospheric refraction, astronomical refraction error.* See **Bemporad formula.**

For bodies near zenith the astronomical refraction is only about 0.1 minute, but for bodies near the horizon it becomes about 30 minutes or more and contributes measurably to the length of the apparent day.

2. Any **refraction** phenomenon observed in the light originating from a source outside of the earth's atmosphere; as contrasted with terrestrial refraction. This is applied only to refraction caused by inhomogeneities of the atmosphere itself, and not to that caused by ice crystals suspended in the atmosphere.

astronomical refraction error = astronomical refraction, sense **1.**

astronomical scintillation. Any **scintillation** phenomena, such as irregular oscillatory motion, variation of intensity, and color fluctuation observed in the light emanating from an extraterrestrial source; to be distinguished from **terrestrial scintillation** primarily in that the light source for the latter lies somewhere within the earth's atmosphere. Also called *stellar scintillation.* See **seeing.**

Astronomical scintillation is typically strongest for celestial objects lying at large zenith distances and is not easily observed by eye for objects whose zenith distances are under 30°. Nonperiodic vibratory motions of stellar images with frequencies of the order of 1 to 10 cycles per second create a troublesome problem of **seeing** in astronomical work. The size of the **schlieren** producing vibratory scintillations has been estimated to be of the order of centimeters, and chromatic scintillations of celestial objects appear to be produced by parcels whose dimensions are of the order of decimeters or, perhaps, meters. Hence, astronomical scintillation is primarily a consequence of the high-frequency, short-wavelength type of atmospheric turbulence.

astronomical seeing. See **seeing.**

astronomical solar time. See **solar time.**

astronomical time. **Mean time** reckoned from the **upper branch** of the meridian. See **astronomical day.**

astronomical triangle. The **navigational triangle,** either terrestrial or celestial, used in the solution of **celestial observations.**

astronomical twilight. See **twilight.**

astronomical unit (*abbr* AU). **1.** A unit of length, usually defined as the distance from the earth to the sun, 149,599,000 kilometers.

This value for the AU was derived from radar observations of the distance of Venus. The value given in astronomical ephemerides, 149,500,000 kilometers, was derived from observations of the minor planet Eros.

2. The unit of distance in terms of which, in the Kepler Third Law, $n^2a^3 = k^2(1 + m)$, the semimajor axis a of an elliptical orbit must be expressed in order that the numerical value of the Gaussian constant k may be exactly 0.01720209895 when the unit of time is the ephemeris day.

In astronomical units, the mean distance of the earth from the sun, calculated by the Kepler law from the observed mean motion n and adopted mass m, is 1.00000003.

astronomical year = tropical year.

astronomy. The science that treats of the location, magnitudes, motions, and constitution of **celestial bodies** and structures.

astrophysics. A branch of **astronomy** that treats of the physical properties of celestial bodies, such as luminosity, size, mass, density, temperature, and chemical composition.

astrotracker = star tracker.

asynchronous computer. An automatic **computer** in which succeeding operations are started by signals indicating the completion of the previous operation, rather than by signals from a master synchronizer. Contrast to **synchronous computer.** See **variable cycle.**

atelectasis. Collapsed or airless state of all or part of a lung. Also called *apneumatosis.*

athodyd. A type of **jet engine** consisting essentially of a duct or tube of varying diameter and open at both ends, which admits air at one end, compresses it by the forward motion of the engine, adds heat to it by the combustion of fuel, and discharges the resulting gases at the other end to produce thrust.

The **ramjet** is an athodyd; the **pulsejet,** especially the earlier type, is usually not considered an athodyd.

atmosphere. **1.** The envelope of **air** surrounding the earth; also the body of gases surrounding or comprising any **planet** or other celestial body. Compare **biosphere, geosphere, hydrosphere, lithosphere.** See **atmospheric shell.** **2. = standard atmos-**

phere. **3.** (*abbr* **atm**) A unit of pressure equal to 14.7 pounds per square inch.

atmospheric boil = terrestrial scintillation.

atmospheric boundary layer = planetary boundary layer.

atmospheric braking. The action of slowing down an object entering the **atmosphere** of the earth or other **planet** from space, by using the **drag** exerted by air or other gas particles in the atmosphere; the action of the drag so exerted.

atmospheric duct. An almost horizontal layer in the **troposphere,** extending from the level of a local minimum of the modified **refractive index** as a function of height, down to the level where the minimum value is again encountered, or down to the earth's surface if the minimum value is not encountered again.

Atmospheric ducts may act as waveguides for radio and radar waves.

atmospheric electric field. **1.** The **electric field strength** of the **atmosphere** at any specified point in space and time. **2.** The distribution of electrical potential in the atmosphere regarded merely from a geometric point of view as a typical scalar field (rarely used).

atmospheric electricity. **1.** Electrical phenomena, regarded collectively, which occur in the earth's **atmosphere.** **2.** The study of electrical processes occurring within the atmosphere.

atmospheric entry. The penetration of any planetary **atmosphere** by any object from outer space; specifically, the penetration of the earth's atmosphere by a manned or unmanned capsule or **spacecraft.**

atmospheric interference = atmospherics.

atmospheric ion. See **ion.**

atmospheric layer = atmospheric shell.

atmospheric noise = atmospherics.

atmospheric optics. The study of the optical characteristics of the **atmosphere** and of the optical phenomena produced by the atmosphere's **suspensoids** and **hydrometeors.** It embraces the study of **refraction, reflection, diffraction, scattering,** and **polarization** of light, but is not commonly regarded as including the study of any other kinds of radiation. Also called *meteorological optics.*

atmospheric oscillation = atmospheric tide.

atmospheric physics = physical meteorology.

atmospheric pressure. The pressure at any point in an **atmosphere** due solely to the weight of the atmospheric gases above the point concerned. See **station pressure, sea-level pressure.**

atmospheric radiation. **Infrared radiation** emitted by or being propagated through the atmosphere. See **insolation.**

Atmospheric radiation, lying almost entirely within the wavelength interval of from 3 to 80 microns, provides one of the most important mechanisms by which the heat balance of the earth-atmosphere system is maintained. Infrared radiation emitted by the earth's surface (terrestrial radiation) is partially absorbed by the water vapor of the atmosphere which in turn reemits it, partly upward, partly downward. This secondarily emitted radiation is then, in general, repeatedly absorbed and reemitted, as the radiant energy progresses through the atmosphere. The downward flux, or counterradiation, is of basic importance in the **greenhouse effect;** the upward flux is essential to the radiative balance of the planet.

atmospheric region = atmospheric shell.

atmospheric refraction. **Refraction** resulting when a **ray** of radiant energy passes obliquely through an **atmosphere.**

It may be called *astronomical refraction* if the ray enters the atmosphere from outer space, or *terrestrial refraction* if it emanates from a point on or near the surface of the earth.

atmospherics. The **radiofrequency** electromagnetic radiations originating, principally, in the irregular surges of charge in thunderstorm lightning discharges. Atmospherics are heard as a quasi-steady background of crackling noise (static) in ordinary amplitude-modulated radio receivers. Also called *atmospheric interference, strays, sferics.* See **sferics.**

Since any acceleration of electric charge leads to emission of electromagnetic radiation, and since the several processes involved in propagation of lightning lead to very large charge accelerations, the lightning channel acts like a huge transmitter, sending out broad band radiation; the 10-kilocycle range propagates best and is used in detecting atmospherics. Atmospherics may occasionally be detected at distances in excess of 2000 miles from their source. Advantage has been taken of this in using radio direction-finding equipment to locate active thunderstorm areas in remote regions and in between weather reporting stations.

atmospheric scintillation = terrestrial scintillation.

atmospheric shell. Any one of a number of strata or *layers* of the earth's atmosphere. Also called *atmospheric layer, atmospheric region.*

Temperature distribution is the most common criterion used for denoting the various shells. The *troposphere* (the *region of change*) is the lowest 10 or 20 kilometers of the atmosphere, characterized by decreasing temperature with height. The top of the troposphere is called the *tropopause.* Above the tropopause, the *stratosphere,* a region in which the temperature generally increases with altitude, extends to the *stratopause,* the top of the inversion layer, at about 50 to 55 kilometers. Above the stratosphere, the *mesosphere,* a region of generally decreasing temperatures with height extends to the *mesopause,* the base of an inversion layer at about 80 to 85 kilometers. The region above the mesopause, in which temperature generally increases with height, is the *thermosphere.*

The distribution of various physicochemical processes

is another criterion. The *ozonosphere*, lying roughly between 10 and 50 kilometers, is the general region of the upper atmosphere in which there is an appreciable ozone concentration and in which ozone plays an important part in the radiative balance of the atmosphere; the *ionosphere*, starting at about 70 or 80 kilometers, is the region in which ionization of one or more of the atmospheric constituents is significant; the *neutrosphere* is the shell below this which is, by contrast, relatively un-ionized; and the *chemosphere*, with no very definite height limits, is the region in which photochemical reactions take place.

Dynamic and kinetic processes are a third criterion. The *exosphere* is the region at the *top* of the atmosphere, above the critical level of escape, in which atmospheric particles can move in free orbits, subject only to the earth's gravitation.

Composition is a fourth criterion. The *homosphere* is the shell in which there is so little photodissociation or gravitational separation that the mean molecular weight of the atmosphere is sensibly constant; the *heterosphere* is the region above this, where the atmospheric composition and mean molecular weight are not constant. The boundary between the two is probably at the level at which molecular oxygen begins to be dissociated, and this occurs in the vicinity of 80 or 90 kilometers.

The term *mesosphere* has been given another definition which does not fit into any logical set of criteria, i.e., the shell between the exosphere and the ionosphere. This use of *mesosphere* has not been widely accepted.

For further subdivisions, see **ionosphere, troposphere, geocorona.**

atmospheric shimmer = **terrestrial scintillation.**

atmospheric tide. Defined in analogy to the oceanic tide as an atmospheric motion on a worldwide scale, in which vertical accelerations are neglected (but compressibility is taken into account). Also called *atmospheric oscillation.*

Both the sun and moon produce atmospheric tides; and there exist both gravitational tides and thermal tides. The harmonic component of greatest amplitude, the 12-hour or semidiurnal solar atmospheric tide, is both gravitational and thermal in origin, the fact that it is greater than the corresponding lunar atmospheric tide being ascribed usually to a resonance in the atmosphere with a free period very close to the tidal period.

Other tides of 6, 8, and 24 hours have been observed.

atmospheric transmissivity. See **transmission coefficient.**

atomic clock. A timekeeping device controlled by the frequency of the natural vibrations of certain atoms.

atomic mass. The mass of a neutral atom of a **nuclide** usually expressed in atomic mass units. See **atomic weight, mass number.**

The atomic mass unit, amu, is exactly one-twelfth of the mass of a neutral atom of the most abundant isotope of carbon, $C^{12} = 12.0000$.

atomic mass unit (*abbr* **amu**). See **atomic mass,** note.

atomic number (*symbol* Z). An integer that expresses the positive charge of the **nucleus** in multiples of the electronic charge e. It is the number of **electrons** outside the nucleus of a neutral (un-ionized) atom and, according to widely accepted theory, the number of **protons** in the nucleus. See **atomic weight,** table IV.

An element of atomic number Z occupies the Zth place in the periodic table of the elements. Its atom has a nucleus with a charge $+Ze$, which is normally surrounded by Z electrons, each of charge $-e$.

For example, the carbon isotope $_6C^{14}$ has an atomic number of 6 and an atomic mass of 14.

atomic particle. One of the particles of which an atom is constituted, as an **electron, neutron,** or a positively charged nuclear particle.

atomic rocket. A projected **rocket engine** in which the energy for the **jetstream** is to be generated by atomic fission or fusion.

atomic weight (*abbr* **at. wt.**). The weight of an atom according to a scale of atomic weight units, awu, valued as one-twelfth the mass of the carbon atom ($C^{12} = 12.00000$). See table IV.

Thus expressed, the atomic weight to the nearest integer is identical with the mass number.

atomic weight unit (*abbr* **awu**). See **atomic weight,** note.

A-trace. The first trace of an oscilloscope, as the upper trace of a **loran** indicator.

attached shock = **attached shock wave.**

attached shock wave. An oblique or conical shock wave that appears to be in contact with the leading edge of an airfoil or the nose of a body in a supersonic flow field. Also called *attached shock.*

attachment. The process in which two **particles** collide and stick together forming a single complex particle. The most common attachment process is the formation of a negative **ion** from electron attachment to an atom or molecule. Some negative ions are unstable, however, and cannot survive.

The usual measure for this process is the attachment coefficient, which on the average is the fraction of a large number of collisions that result in attachment. Typical values of this fraction run from 1 in 10,000 to 1 in 1,000.

attachment coefficient. See **attachment,** note.

attenuation. Reduction in intensity.

attenuation coefficient (*symbol* α). A measure of the space rate of attenuation of any transmitted **electromagnetic radiation.** The attenuation coefficient is defined by

$$dI = -\alpha\, I_0 dx$$

or

$$I = I_0 e^{-\alpha x}$$

where I is the flux density at the selected point in space; I_0 is the flux density at the source; x is the distance from the source; and α is the attenuation coefficient.

In general, the attenuation coefficient is specified only when the attenuation is known to be due to both absorption and scattering, or when it is impossible to determine

TABLE IV.—RELATIVE ATOMIC WEIGHTS (1963)[a]

Based on atomic mass of $C^{12} = 12$

Name	Symbol	Atomic number	Atomic weight[b]	Name	Symbol	Atomic number	Atomic weight[b]
Actinium	Ac	89	. . .	Mercury	Hg	80	200.59
Aluminium	Al	13	26.9815	Molybdenum	Mo	42	95.94
Americium	Am	95	. . .	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.75	Neon	Ne	10	20.183
Argon	Ar	18	39.948	Neptunium	Np	93	. . .
Arsenic	As	33	74.9216	Nickel	Ni	28	58.71
Astatine	At	85	. . .	Niobium	Nb	41	92.906
Barium	Ba	56	137.34	Nitrogen	N	7	14.0067
Berkelium	Bk	97	. . .	Nobelium	No	102	. . .
Beryllium	Be	4	9.0122	Osmium	Os	76	190.2
Bismuth	Bi	83	208.980	Oxygen	O	8	15.9994[c]
Boron	B	5	10.811[c]	Palladium	Pd	46	106.4
Bromine	Br	35	79.909[d]	Phosphorus	P	15	30.9738
Cadmium	Cd	48	112.40	Platinum	Pt	78	195.09
Caesium	Cs	55	132.905	Plutonium	Pu	94	. . .
Calcium	Ca	20	40.08	Polonium	Po	84	. . .
Californium	Cf	98	. . .	Potassium	K	19	39.102
Carbon	C	6	12.01115[c]	Praseodym.	Pr	59	140.907
Cerium	Ce	58	140.12	Promethium	Pm	61	. . .
Chlorine	Cl	17	35.453[d]	Protactinium	Pa	91	. . .
Chromium	Cr	24	51.996[d]	Radium	Ra	88	. . .
Cobalt	Co	27	58.9332	Radon	Rn	86	. . .
Copper	Cu	29	63.54	Rhenium	Re	75	186.2
Curium	Cm	96	. . .	Rhodium	Rh	45	102.905
Dysprosium	Dy	66	162.50	Rubidium	Rb	37	85.47
Einsteinium	Es	99	. . .	Ruthenium	Ru	44	101.07
Erbium	Er	68	167.26	Samarium	Sm	62	150.35
Europium	Eu	63	151.96	Scandium	Sc	21	44.956
Fermium	Fm	100	. . .	Selenium	Se	34	78.96
Fluorine	F	9	18.9984	Silicon	Si	14	28.086[c]
Francium	Fr	87	. . .	Silver	Ag	47	107.870[d]
Gadolinium	Gd	64	157.25	Sodium	Na	11	22.9898
Gallium	Ga	31	69.72	Strontium	Sr	38	87.62
Germanium	Ge	32	72.59	Sulfur	S	16	32.064[c]
Gold	Au	79	196.967	Tantalum	Ta	73	180.948
Hafnium	Hf	72	178.49	Technetium	Tc	43	. . .
Helium	He	2	4.0026	Tellurium	Te	52	127.60
Holmium	Ho	67	164.930	Terbium	Tb	65	158.924
Hydrogen	H	1	1.00797[c]	Thallium	Tl	81	204.37
Indium	In	49	114.82	Thorium	Th	90	232.038
Iodine	I	53	126.9044	Thulium	Tm	69	168.934
Iridium	Ir	77	192.2	Tin	Sn	50	118.69
Iron	Fe	26	55.847[d]	Titanium	Ti	22	47.90
Krypton	Kr	36	83.80	Tungsten	W	74	183.85
Lanthanum	La	57	138.91	Uranium	U	92	238.03
Lawrencium	Lr	103	. . .	Vanadium	V	23	50.942
Lead	Pb	82	207.19	Xenon	Xe	54	131.30
Lithium	Li	3	6.939	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.97	Yttrium	Y	39	88.905
Magnesium	Mg	12	24.312	Zinc	Zn	30	65.37
Manganese	Mn	25	54.9380	Zirconium	Zr	40	91.22
Mendelevium	Md	101	. . .				

[a] Reprinted by permission of the International Union of Pure and Applied Chemistry.

[b] The values given apply to elements as they exist in nature, without artificial alteration of their isotopic composition, and, further, to natural mixtures that do not include isotopes of radiogenic origin.

[c] Atomic weights so designated are known to be variable because of natural variations in isotopic composition. The observed ranges are:

Hydrogen	± 0.00001	Carbon	± 0.00005	Silicon	± 0.001
Boron	± 0.003	Oxygen	± 0.0001	Sulfur	± 0.003

[d] Atomic weights so designated are believed to have the following experimental uncertainties:

Chlorine	± 0.001	Iron	± 0.003	Silver	± 0.003
Chromium	± 0.001	Bromine	± 0.002		

which is the cause. See **absorption coefficient, scattering coefficient.**

attenuation constant. **1.** A measure of the rate of attenuation per unit length; the rate of flux-density (or power) reduction as energy (visual, electromagnetic, acoustic) propagates from its source. Also called *attenuation factor, decay constant.* Compare **attenuation coefficient.**

For free-space transmission of radar frequency energy, the attenuation constant is usually expressed in decibels per mile or kilometer (db/mi or db/km).

2. Specifically, of a traveling plane wave at a given frequency, the relative rate of decrease of amplitude of a field component (or of voltage or current) in direction of propagation in nepers per unit length.

attenuation factor = **attenuation constant.**

attenuation length. The reciprocal of the **attenuation coefficient.**

attenuation ratio. The magnitude of the **propagation ratio.**

attitude. The position or orientation of an aircraft, spacecraft, etc., either in motion or at rest, as determined by the relationship between its **axes** and some reference line or plane or some fixed system of reference axes.

attitude control. **1.** The regulation of the **attitude** of an aircraft, spacecraft, etc. **2.** A device or system that automatically regulates and corrects attitude, especially of a pilotless vehicle.

attitude gyro. **1.** A **gyro**-operated flight instrument that indicates the **attitude** of an aircraft or spacecraft with respect to a reference coordinate system throughout 360° of rotation about each axis of the craft.

This instrument is similar to the **artificial horizon,** but has greater angular indication.

2. Broadly, any gyro-operated instrument that indicates attitude.

attitude jet. A **jetstream** used to correct or alter the attitude of a flying body either in the atmosphere or in space; the **nozzle** that directs this jetstream.

The jet may be continuous or intermittent. A **vernier engine** is sometimes used to produce it.

attribute. A characteristic of a thing which can be appraised only in terms of whether it does or does not exist. See **method of attributes.**

attributes testing. A **reliability** test procedure where the items under test are classified according to qualitative rather than quantitative characteristics.

AU (*abbr*) = **astronomical unit.**

audible sound. Sound containing **frequency** components lying between about 15 and 20,000 cycles per second.

audio. Pertaining to the **audiofrequency range.**

The word *audio* may be used as a modifier to indicate a device or system intended to operate at audiofrequencies, e.g., *audioamplifier.*

audiofrequency. Any **frequency** corresponding to a normally audible **sound wave.** See **audiofrequency range.**

audiofrequency range. The range of frequencies to which the human ear is sensitive, approximately 15 cycles per second to 20,000 cycles per second. Also called *audiorange.*

audiorange = **audiofrequency range.**

auditory sensation area. In acoustics, the frequency region enclosed by the curves defining the **threshold of pain** and the **threshold of audibility.**

Auger shower. A very large **cosmic-ray** shower. Also called *extensive air shower.*

augmentation. The apparent increase in the **semidiameter** of a celestial body, as observed from the earth, as its altitude increases, due to the reduced distance from the observer.

The term is used principally in reference to the moon.

augmentation correction. A correction due to **augmentation,** particularly that sextant altitude correction due to the apparent increase in the **semidiameter** of a celestial body as its altitude increases.

augmenter tube. A tube or pipe, usually one of several, through which the exhaust gases from an aircraft **reciprocating engine** are directed especially to provide additional thrust.

Aur, Auri. International Astronomical Union abbreviations for *Auriga.* See **constellation.**

aural null. See **null.**

Auriga (*abbr* **Aur, Auri**). See **constellation.**

aurora. The sporadic radiant emission from the **upper atmosphere** over middle and high latitudes. It is believed to be due primarily to the **emission** from nitrogen—atomic N *I* and N *II*, molecular N_2, and ionic N_2^+; atomic oxygen (O *I* and O *II*); atomic sodium (Na *I*); the hydroxyl radical (OH); and hydrogen. Compare **airglow.**

According to various theories, auroras seem definitely to be related to magnetic storms and the influx of charged particles from the sun. The exact details of the nature of the mechanisms involved are still being investigated, but release of trapped particles from the Van Allen belt apparently plays an important part. The aurora is most intense at times of magnetic storms (when it is also observed farthest equatorward), and shows a periodicity which is related to the sun's 27-day rotation period and the 11-year sunspot cycle. The distribution with height shows a pronounced maximum near 100 kilometers. The lower limit is probably near 80 kilometers.

The aurora can often be clearly seen, and it assumes a

variety of shapes and colors which are characteristic patterns of auroral emission.

The following is the general classification and abbreviations of the forms of the auroras adopted by the International Union of Geodesy and Geophysics in 1930 for reporting of visual observations. The classification was modified slightly and expanded in 1963. The new classification is described in the *International Auroral Atlas*, Aldine Pub. Co., Chicago, 1963.

I. Forms without ray structure:

HA (*abbr* for *homogeneous quiet arcs*). These can appear near the horizon, and between the arc and the horizon a dark segment is often seen. These arcs can be narrow or broad, and are very often diffuse along the upper border but sharp along the lower one.

HB (*abbr* for *homogeneous bands*). These forms do not have the regular shape of the arcs; they are more rapidly moving phenomena. The lower border is often irregular and sharp. The breadth can vary from a very narrow band to a band which is so large that it resembles a curtain hanging down. These bands very often turn into bands with ray structure.

PA (*abbr* for *pulsating arcs*). Parts of an arc flash up and disappear regularly within a period of about 20 seconds. This form quite often stands isolated in the sky without other auroras.

DS (*abbr* for *diffuse luminous surfaces*). These either appear like a diffuse veil or glow over great parts of the heavens without distinct boundaries, often appearing after intense displays of rays and curtains, or as more isolated feeble luminous streaks which sometimes bear a striking resemblance to clouds. Sometimes large areas of the heavens can be discolored by a green, violet, or red diffuse light.

PS (*abbr* for *pulsating surfaces*). Diffuse patches appear and disappear rhythmically at the same place, retaining the same irregular shape. When the patches are lying near the magnetic zenith the contours can be more sharp, and form a sort of corona. These forms appear often in connection with flaming auroras.

G (*abbr* for *feeble glow near the horizon resembling the dawn*). Of white or redlike color, this form is often the upper part of an arc whose lower border is below the horizon.

II. Forms with ray structure: These forms consist of short or long rays which can be arranged in different ways.

RA (*abbr* for *arcs with ray structure*). A homogeneous arc which has remained quiet and unaltered for a rather long time may become sharp and luminous along the lower border and then very rapidly change into an arc of rays. The rays can be short or long.

RB (*abbr* for *bands with ray structure*). These resemble the bands mentioned under H.B. but are constituted of a series of rays which are arranged close to each other along the band, or they can appear more scattered. Often a series of parallel bands appear. When a band is near the magnetic zenith it may have the form of a corona.

D (*abbr* for *draperies*). If the rays become very long the band appears like a curtain or drapery whose lower border is often more luminous. Several parallel curtains frequently appear at the same time. Near the zenith the curtain may have a fanlike form on account of the perspective.

R (*abbr* for *rays*). The rays can be isolated, narrow or broad, short or long. They may appear in great segments or like masses or rays, very often resembling curtains.

C (*abbr* for *corona*). When the rays approach the magnetic zenith they seem, on account of the perspective, to converge to this point and form a corona. This may be formed by long rays or by short ones, it may be complete or incomplete. A corona can also be formed by bands, draperies, or more diffuse forms near the magnetic zenith.

III. **Flaming auroras** (*abbr* **F**). A characteristic, rapidly moving form, consisting of strong waves of light which move upwards, one after the other, in the direction of the magnetic zenith. The waves have the form of detached arcs which move upwards normally to the direction of the arc; they can be compared to invisible waves illuminating broad rays and patches which appear and disappear rhythmically when the waves pass them. The flaming aurora frequently appears after strong displays of rays and curtains and is often followed by the formation of a corona.

aurora australis. The aurora of the Southern Hemisphere.

aurora borealis. The aurora of northern latitudes. Also called *aurora polaris, northern lights.*

auroral zone. A roughly circular band around either **geomagnetic pole** above which there is a maximum of auroral activity. It lies about 10° to 15° of **geomagnetic latitude** from the geomagnetic poles.

The auroral zone broadens and extends equatorward during intense auroral displays.

The northern auroral zone is centered along a line passing near Point Barrow, Alaska, through the lower half of Hudson Bay, slightly off the southern tip of Greenland, through Iceland, northern Norway and northern Siberia. Along this line auroras are seen on an average of 240 nights a year. The frequency of auroras falls off both to the north and to the south of this line but more rapidly to the south. The most severe blackouts occur in the auroral zone.

aurora polaris = **aurora borealis.**

austausch coefficient = **exchange coefficient.**

australite. See **tektite.**

authorized carrier frequency. A specific **carrier frequency** authorized for use, from which the actual carrier frequency is permitted th deviate, solely because of frequency instability, by an amount not to exceed the **frequency tolerance.**

autoconvection gradient = **autoconvective lapse rate.**

autoconvective lapse rate. The **environmental lapse rate** of temperature in an atmosmosphere in which the density is constant with height (homogeneous atmosphere), equal to g/R, where g is the acceleration of gravity and R the gas constant. For dry air the autoconvective lapse rate is approximately $+\ 3.4 \times 10^{-4}$ °C per centimeter. Also called *autoconvection gradient.*

autocorrelation. In statistics the simple linear internal **correlation** of members of a time series (ordered in time or other domains).

autocorrelation function. Autocorrelation for variable lag.

autoigniting propellant. Any **propellant** that ignites by itself without external stimulation.

autoignition temperature. The temperature at which combustible materials ignite spontaneously in air.

autokinetic illusion. The illusion of a fixed object or light moving when gazed at steadily.

automatic celestial navigation = celestial guidance.

automatic computer. A **computer** which can automatically perform a comprehensive sequence of operations.

automatic control. Control of devices and equipment, including aerospace vehicles, by automatic means.

automatic data processing system. An electronic system that includes an electronic **data processing** system plus auxiliary and connecting communications equipment.

automatic direction finder (*abbr* **ADF**). A radio **direction finder** which automatically and continuously provides a measure of the direction of arrival of the received signal. Data are usually displayed visually.

automatic frequency control (*abbr* **AFC**). An arrangement whereby the **frequency** of an **oscillator** is automatically maintained within specified limits.

automatic gain control (*abbr* **AGC**). A process by which **gain** is automatically adjusted as a function of input or other specified **parameter.**

automatic pilot. Equipment which automatically stabilizes the attitude of a vehicle about its **pitch, roll,** and **yaw** axes. Also called *autopilot.*

automatic stability. Stability achieved with the controls operated by automatic devices, as by an **automatic pilot.**

automatic tracking. Tracking in which a **servomechanism** automatically follows some characteristic of the signal; specifically, a process by which tracking or data acquisition systems are enabled to keep their antennas continually directed at a moving target without manual operation.

autopilot = automatic pilot.

autosyn. (A trade name, from *autosynchronous*, often capitalized.) A remote-indicating instrument or system based upon the synchronous-motor principle, in which the angular position of the rotor of one motor at the measuring source is duplicated by the rotor of the indicator motor, used, e.g., in fuel-quantity or fuel-flow measuring systems, position-indicating systems, etc.

autosynchronous. Full term for *autosyn.*

autumnal equinox. 1. That point of intersection on the **celestial sphere** of the **ecliptic** and the **celestial equator** occupied by the sun as it changes from north to south **declination,** on or about September 23. Also called *September equinox, first point of Libra.* **2.** That instant the sun reaches the point of zero declination when crossing the celestial equator from north to south.

auxiliary circle. In celestial mechanics, a circumscribing circle to an orbital **ellipse** with a radius a, the **semimajor axis.**

The auxiliary circle is related to the ellipse by

$$QN = Q'N(1 - e^2)^{1/2}$$

where e is the eccentricity; Q is any point on the ellipse; N is the foot of the perpendicular through Q to the line of apsides; and Q' is the intersection of the perpendicular and the auxiliary circle.

auxiliary fluid ignition. A method of ignition of a liquid-propellant **rocket engine** in which a liquid which is **hypergolic** with either the **fuel** or the **oxidizer** is injected into the combustion chamber to initiate combustion.

Aniline is used as an auxiliary fluid with nitric acid and some organic fuels to initiate combustion.

auxiliary landing gear. That part or parts of a **landing gear,** as an outboard wheel, which is intended to stabilize the craft on the surface but which bears no significant part of the weight.

auxiliary power unit (*abbr* **APU**). A power unit carried on an aircraft or spacecraft which can be used in addition to the main sources of power of the craft.

avalanche. The cumulative process in which charged **particles** accelerated by an electric field produce additional charged particles through **collision** with neutral gas molecules or atoms. See **Townsend ionization coefficient.**

average = arithmetic mean.

average deviation. In statistics, the average or arithmetic mean of the deviations, taken without regard to sign, from some fixed value, usually the **arithmetic mean** of the data. Also called *mean deviation.* See **standard deviation.**

average information content. The average of the **information content** per symbol emitted from a source. Also called *entropy* and *negentropy.*

aviation medicine. See **aerospace medicine.**

Avogadro constant = Avogadro number.

Avogadro law. See **Avogadro number.**

Avogadro number, Avogadro constant (*symbol* N_A). The number of molecules in 1 mole of gas (6.02252×10^{22} per mole).

That this number is a constant for permanent gases is the Avogadro law: under normal conditions, i.e., pressure of 1 standard atmosphere and temperature of 0° C, the volume occupied by 1 mole of gas is the same for all permanent gases (22,414 cubic centimeters). See **Loschmidt number.**

axial flow compressor. A rotary **compressor** having interdigitated rows or stages of rotary and of stationary blades through which the flow of fluid is substantially parallel to the rotor's axis of rotation. Compare **centrifugal compressor.**

axis (*plural* **axes**). **1.** A straight line about which a body rotates, or along which its center of gravity moves (axis of translation). **2.** A straight line around which a plane figure may rotate to produce a solid; a line of symmetry. **3.** One of a set of reference lines for a **coordinate** system.

axis of freedom. Of a **gyro,** an axis about which a **gimbal** provides a **degree of freedom.**

axis of thrust = thrust axis.

azimuth. **1.** Horizontal direction or **bearing.** Compare **azimuth angle.** **2.** In navigation, the horizontal direction of a **celestial** point from a **terrestrial** point, expressed as the angular distance from a reference direction, usually measured from 0° at the reference direction clockwise through 360°.

An azimuth is often designated as *true, magnetic, compass, grid,* or *relative* as the reference direction is true, magnetic, compass, grid north, or heading, respectively. Unless otherwise specified, the term is generally understood to apply to *true azimuth,* which may be further defined as the arc of the horizon, or the angle at the zenith, between the north part of the celestial **meridian** or principal vertical circle and a vertical circle, measured from 0° at the north part of the principal vertical circle clockwise through 360°.

3. In astronomy, the direction of a celestial point from a terrestrial point measured clockwise from the north or the south point of the **meridian** plane. See **horizon system.** **4.** In surveying, the horizontal direction of an object measured clockwise from the south point of the meridian plane.

In surveying, an azimuth of a celestial body is called an *astronomic azimuth.*

azimuth angle. **1.** Azimuth measured from 0° at the north or south reference direction clockwise or counterclockwise through 90° or 180°.

Azimuth angle is labeled with the reference direction as a prefix and the direction of measurement from the reference direction as a suffix. Thus, azimuth angle S 144° W is 144° west of south, or azimuth 324°. When azimuth angle is measured through 180°, it is labeled N or S to agree with the latitude and E or W to agree with the meridian angle.

2. In surveying, an angle in triangulation or in traverse through which the computation of azimuth is carried.

azimuth error. An error in the indicated **azimuth** of a target detected by radar, resulting from horizontal **refraction.** Compare **range error.**

Inasmuch as significant horizontal gradients of **index of refraction** are very uncommon in the atmosphere, these errors almost invariably are negligible. Seacoast areas may give rise on occasion to appreciable horizontal bending of radio waves because of the contrast of refractive index values between the air over land and the air over water.

azimuth marker. **1.** A scale encircling the plan position indicator (PPI) scope of a **radar** on which the **azimuth** of a target from the radar may be measured. **2.** Reference limits inserted electronically at 10° or 15° intervals which extend radially from the relative position of the radar on an offcenter PPI scope. These are employed for target azimuth determination when the radar position is not at the center of the PPI scope and hence the fixed azimuth scale on the edge of the scope cannot be employed.

On such markers north is usually 0°, east 90°, etc. Occasionally, on ship or airborne radars, 0° is used to indicate the direction in which the craft is heading, in which cases the relative bearing, not azimuth, of the target is indicated.

azran. *Az*imuth and *ran*ge.

This term was coined in the field of radar, and has since been extended in application to the locating of any object (or target) by means of polar coordinates.

Azusa. A short-baseline, continuous-wave, phase comparison, single-station, tracking system operating at C-band and giving two **direction cosines** and **slant range** which can be used to determine space position and velocity.

B

babble. The aggregate **crosstalk** from a large number of communications channels.

Babinet point. One of the three commonly detectable points of zero **polarization** of **diffuse sky radiation,** neutral points, lying along the **vertical circle** through the sun; the other two are the **Arago point** and **Brewster point.**

The Babinet point typically lies only 15° to 20° above the sun, and hence is difficult to observe because of solar glare. The existence of this neutral point was discovered by Babinet in 1840.

background. Any effect in a sensor or other apparatus or system above which the phenomenon of interest must manifest itself before it can be observed. See **background counts, background noise.**

background counts. In radiation counters, responses of the counting system caused by **radiation** coming from sources other than that to be measured.

background luminance. In visual-range theory, the **luminance** (brightness) of the background against which a target is viewed. Compare **adaptation luminance.**

background noise. **1.** In recording and reproducing, the total system **noise** independent of whether or not a signal is present. The signal is not to be included as part of the noise. **2.** In receivers, the noise in the absence of signal modulation on the carrier.

Ambient noise detected, measured, or recorded with the signal becomes part of the background noise.

Included in this definition is the interference resulting from primary power supplies, that separately is commonly described as **hum.**

background return. See **clutter.**

backlash. Dead space or unwanted movement in a **control system.**

backout. An undoing of things already done during a **countdown,** usually in reverse order.

back pressure. Pressure exerted backward; in a field of fluid flow, a pressure exerted contrary to the pressure producing the main flow.

back radiation = **counterradiation.**

back scatter = **backward scatter.**

back scattering = **backward scatter.**

back-scattering cross section. See **scattering cross section.**

back-to-chest acceleration. See **physiological acceleration,** table.

backup. **1.** An item kept available to replace an item which fails to perform satisfactorily. **2.** An item under development intended to perform the same general functions of another item also under development performs.

backward scatter. The **scattering** of radiant energy into the hemisphere of space bounded by a plane normal to the direction of the incident **radiation** and lying on the same side as the incident ray; the opposite of **forward scatter.** Also called *back scattering.*

Atmospheric backward scatter depletes 6 to 9 percent of the incident solar beam before it reaches the earth's surface.

In radar usage, *backward scatter* refers only to that radiation scattered at 180° to the direction of the incident wave.

backward wave. In **traveling-wave tubes,** a wave whose **group velocity** is opposite to the direction of electron-stream motion.

baffle. A plate, grating, or the like used especially to block, hinder, or divert a flow or to hinder the passage of something, as: (a) A plate used to conduct, or help to conduct, a flow of cooling air around an engine cylinder. (b) A plate, wall, or the like in a fuel tank or other liquid container, used especially to prevent sloshing of the contents. (c) A ridge or wall on the top of a piston in a two-stroke-cycle engine, used to deflect the incoming mixture upward and divert it from the exhaust port. (d) A plate in the forward section of a pitot tube, used to reduce turbulence in the tube and to prevent dirt, moisture, etc., from entering the system.

bailout bottle. A personal supply of oxygen usually contained in a cylinder under pressure and utilized when the individual has left the central oxygen system as in a parachute jump.

bakeout. The **degassing** of surfaces of a vacuum system by heating during the pumping process.

balance. **1.** The equilibrium attained by an aircraft, rocket, or the like when forces and **moments** are acting upon it so as to produce steady flight, especially without rotation about its axes; also used with reference to equilibrium about any specified **axis,** as, *an airplane in balance about its longitudinal axis.* **2.** A weight

that counterbalances something, especially on an aircraft control surface, a weight installed forward of the hinge axis to counterbalance the surface aft of the hinge axis.

balanced amplifier. An amplifier circuit in which there are two identical signal branches connected so as to operate in phase opposition and with input and output connections each balanced to ground. Also called *push-pull amplifier.*

balanced circuit. A **circuit,** the two sides of which are electrically alike and symmetrical with respect to a common reference point, usually ground.

balanced detector. A **demodulator** for frequency-modulation systems. In one form the output consists of the rectified difference of the two voltages produced across two resonant circuits, one circuit being tuned slightly above the **carrier frequency** and the other slightly below.

balanced modulator. A device in which the **carrier** and modulating signal are so introduced that, after modulation takes place, the output contains the two **sidebands** without the carrier.

ballistic body. A body free to move, behave, and be modified in appearance, contour, or texture by ambient conditions, substances, or forces, as by the pressure of gases in a gun, by rifling in a barrel, by gravity, by temperature, or by air particles.

A rocket with a self-contained propulsion unit is not considered a ballistic body during the period of its guidance or propulsion.

ballistic camera. A ground-based camera using multiple exposures on the same plate to record the **trajectory** of a rocket.

ballistic condition. A condition affecting the behavior of a vehicle in flight.

Ballistic conditions include the velocity, weight, shape, and size of the vehicle; likewise the density and temperature of the ambient element, the magnetic field, etc.

ballistic density. A representation of the atmospheric density actually encountered by a projectile in flight, expressed as a percentage of the density according to the **standard artillery atmosphere.**

Thus, if the actual density distribution produced the same effect upon a projectile as the standard density distribution, the ballistic density would be 100 percent.

ballistic missile. A missile designed to operate primarily in accordance with the laws of **ballistics.**

A ballistic missile is guided during a portion of its flight, usually the upward portion, and is under no thrust from its propelling system during the latter portion of its flight; it describes a trajectory similar to that of an artillery shell.

ballistic reentry. Nonlifting **reentry.**

ballistics. The science that deals with the motion, behavior, and effects of projectiles, especially bullets, aerial bombs, rockets, or the like; the science or art of designing and hurling projectiles so as to achieve a desired performance.

ballistic temperature. That temperature (in °F) which, when regarded as a surface temperature and used in conjunction with the lapse rate of the **standard artillery atmosphere,** would produce the same effect on a projectile as the actual temperature distribution encountered by the projectile in flight.

ballistic trajectory. The **trajectory** followed by a body being acted upon only by gravitational forces and the resistance of the medium through which it passes.

A rocket without lifting surfaces is in a *ballistic trajectory* after its engines cease operating.

ballistic vehicle. A nonlifting vehicle; a vehicle that follows a **ballistic trajectory.**

ballistic wind. That constant wind which would produce the same effect upon the **trajectory** of a projectile as the actual wind encountered in flight. Ballistic winds can be regarded as made up of **range wind** and **crosswind** components. See **zone wind.**

ball lightning. A relatively rare form of lightning, consisting of a reddish, luminous ball, of the order of 1 foot in diameter, which may move rapidly along solid objects or remain floating in midair. Hissing noises emanate from such balls, and they sometimes explode noisily but may also disappear noiselessly. Also called *globe lightning.*

It has been suggested that ball lightning is a temporarily stable *plasma.*

balloon-type rocket. A liquid-fuel **rocket,** such as Atlas, that requires the pressure of its **propellants** (or other gases) within it to give it structural integrity.

ballute. A cross between a balloon and a parachute, used to brake the free fall of sounding rockets.

band. **1.** = **frequency band.** **2.** = **absorption band.** **3.** A group of tracks on a **magnetic drum.** **4.** = **auroral band.** See **aurora.**

band-elimination filter. A **wave filter** that attenuates one **frequency band,** neither the critical nor cutoff frequencies being zero or infinite.

band of position. An area extending to either side of a **line of position** of imperfect accu-

racy, within which a craft is considered to be located.

band-pass filter. A **wave filter** that has a single transmission band extending from a lower cutoff frequency greater than zero to a finite upper cutoff frequency.

bands with ray structure (*abbr* **R.B.**). See **aurora.**

bandwidth. 1. In an **antenna,** the range of **frequencies** within which its performance, in respect to some characteristic, conforms to a specified standard. **2.** In a **wave,** the least frequency interval outside of which the **power spectrum** of a time-varying quantity is everywhere less than some specified fraction of its value at a reference frequency. **3.** The number of cycles per second between the limits of a **frequency band.**

Sense 2 permits the spectrum to be less than the specified fraction within the interval. Unless otherwise stated, the reference frequency is that at which the spectrum has its maximum value.

4. In information theory, the information-carrying capacity of a communications channel.

bang-bang control. Flicker control, especially as applied to rockets.

Bang-bang in this term is imitative, arising from the noise made by control mechanisms slamming first to one side, then to the other, in this sort of control.

bar. A unit of **pressure** equal to 10^6 dyne per square centimeter (10^6 barye), 1000 millibars, 29.53 inches of mercury. See **torr.**

Some writers have used bar as equivalent to *barye* (1 dyne per square centimeter).

baralyme. A commercial trade name for a type of carbon dioxide absorber, a mixture of calcium hydroxide and barium hydroxide.

Bárány chair. (After Robert Bárány, 1876–1936, Swedish physician.) A kind of chair in which a person is revolved to test his susceptibility to **vertigo.**

bare core. A **reactor core** without a **reflector.**

barn (*abbr* **b**). A unit of area for measuring a **nuclear cross section.** One barn equals 10^{-24} square centimeter.

barocline = baroclinic.

baroclinic. Of, pertaining to, or characterized by **baroclinity.** Sometimes called *barocline.*

baroclinicity = baroclinity.

baroclinity. The state of stratification in a fluid in which surfaces of constant pressure (isobaric) intersect surfaces of constant density (isosteric). The number, per unit area, of isobaric-isosteric **solenoids** intersecting a given surface is a measure of the baroclinity. Also called *baroclinicity, barocliny.*

Barotropy is the state of zero baroclinity. Since the presence of solenoids (baroclinity) complicates the dynamics of the fluid, there has been much investigation of the extent to which an **atmosphere,** though obviously a baroclinic fluid, can be dynamically treated as barotropic. See **equivalent barotropic model.**

barocliny = baroclinity.

barometer. An instrument used to measure **atmospheric pressure.**

barometric altimeter = pressure altimeter.

barometric pressure = atmospheric pressure.

barometric wave. Any **wave** in the atmospheric pressure field. The term is usually reserved for short-period variations not associated with cyclonic-scale motions or with atmospheric tides. See **pressure wave,** sense **2.**

barosphere. The atmosphere below the **critical level of escape.**

baroswitch. (From *baro*metric *switch*). **1.** Specifically, a pressure-operated switching device used in a **radiosonde.** In operation, the expansion of an aneroid capsule causes an electrical contact to scan a radiosonde commutator composed of conductors separated by insulators. Each switching operation corresponds to a particular pressure level. The contact of an insulator or a conductor determines whether temperature, humidity, or reference signals will be transmitted. **2.** Any switch operated by a change in **atmospheric pressure.**

barotropic. Of, pertaining to, or characterized by a condition of **barotropy.**

barotropic disturbance. 1. An atmospheric wave in a two-dimensional nondivergent flow, the driving mechanism for which lies in the variation of **vorticity** of the basic current and/or in the variation of the vorticity of the earth about the **local vertical.** When the basic current is uniform, the wave is a *Rossby wave.* Also called *barotropic wave.* **2.** An atmospheric wave of cyclonic scale in which troughs and ridges are approximately vertical.

barotropic model. Any of a number of **model atmospheres** in which some of the following conditions exist throughout the motion: coincidence of pressure and temperature surfaces; absence of vertical **wind shear;** absence of vertical motions; absence of horizontal velocity divergence; and conservation of the vertical component of **absolute vorticity.**

barotropic vorticity equation. The **vorticity equation** in the absence of horizontal divergence and vertical motion, so that the **absolute vorticity** of a parcel is conserved:

$$\frac{d}{dt}(\zeta + f) = 0$$

where ζ is the **relative vorticity** and f is the **coriolis parameter.**

This equation may also be interpreted as governing vertically averaged flow in which divergence is present but wind direction is constant with height. See **equivalent barotropic model.**

barotropic wave = barotropic disturbance.

barotropy. The state of a fluid in which surfaces of constant density (or temperature) are coincident with surfaces of constant pressure; it is the state of zero **baroclinity.** Mathematically, the equation of barotropy states that the gradients of the density and pressure fields are proportional:

$$\Delta\rho = B\,\Delta p$$

where ρ is the density; p is the pressure; and B is a function of thermodynamic variables, called the coefficient of barotropy.

With the **equation of state,** this relation determines the spatial distribution of all state parameters once these are specified on any surface. For a **homogeneous atmosphere,** $B = 0$; for an **adiabatic atmosphere,**

$$B = c_v/c_pRT$$

where c_v and c_p are the specific heats at constant volume and pressure, respectively; R is the gas constant; and T is the Kelvin temperature; for an **isothermal atmosphere,** $B = 1/RT$.

barycenter. The center of mass of a system of masses, as *the barycenter of the earth-moon system.*

barycentric elements. Orbital elements referred to the **center of mass** of the solar system.

barye. The pressure unit of the **centimeter-gram-second system** of physical units; equal to one dyne per square centimeter (0.001 millibar). Sometimes called *bar* or *microbar.*

base. A quantity, the powers of which are assigned as the unit value of columns in a **numeric** system; for example, *two* is the base in **binary notation,** and *ten* in **decimal notation.** Also called *radix.* See **logarithm, binary notation.**

base drag. Drag owing to a **base pressure** lower than the ambient pressure. It is a part of the **pressure drag.**

base line. 1. Any line which serves as the basis for measurement of other lines, as in a surveying triangulation, measurement of auroral heights, etc. **2.** The **geodesic line** between two stations operating in conjunction for the determination of a line of position, as the two stations constituting a loran rate. **3.** In radar, the line traced on **amplitude-modulated indicators** which corresponds to the power level of the weakest echo detected by the radar. It is retraced with every pulse transmitted by the radar, but appears as a nearly continuous display on the scope.

Target signals show up as perpendicular deviations from the base line; range is measured along the base line; signal strength is indicated by the magnitude of the deviations; and the type of target usually can be determined by the appearance of the deviations.

base point. In computer terminology, the character, or the location of an implied symbol, which separates the integral part of an expression in **positional notation** from the fractional part; the point which marks the place between the zero and negative powers of the **base.** Also called *radix point.* See **binary point, decimal point, fixed point, floating point.**

base pressure. In aerodynamics, the **pressure** exerted on the base, or extreme aft end, of a body, as of a cylindrical or boattailed body or of a blunt-trailing-edge wing, in a fluid flow.

base-timing sequencing (*abbr* **BT sequencing**). The control of the time sharing of a single **transponder** between several ground transmitters through the use of suitable coded timing signals.

basic thermal radiation. Thermal radiation from a **quiet sun.**

baud. A unit of signaling speed. The speed in bauds is the number of **code elements** per second.

Baumé scale (*abbr* **Bé**). Either of two scales sometimes used to graduate **hydrometers;** one scale is for liquids heavier than water, the other for liquids lighter than water.

Bayard-Alpert ionization gage. A type of **ionization vacuum gage** using a tube with an electrode structure designed to minimize X-ray induced electron emission from the ion collector.

Bayer letter. The Greek (or Roman) letter used in a **Bayer name.**

Bayer name. The Greek (or Roman) letter and the possessive form of the Latin name of a **constellation,** used as a star name. Examples are α *Cygni* (Deneb), β *Orionis* (Rigel), and η *Ursae Majoris* (Alkaid). See **navigational stars,** table.

B-display. In radar, a rectangular **display** in which **targets** appear as **blips** with **bearing** indicated by the horizontal coordinate and distance by the vertical coordinate. Also called *B-scan* or *B-scope.*

beacon. 1. A light, group of lights, electronic apparatus, or other device that guides, orients,

or warns aircraft, spacecraft, etc. in flight. **2.** A structure, building, or station where such a device is mounted or located. See **radar beacon, radio beacon.**

beacon delay. The amount of inherent delay within a **beacon,** i.e., the time between the arrival of a signal and the response of the beacon.

beacon skipping. A condition where **transponder** return pulses from a **beacon** are missing at the interrogating **radar.**

Beacon skipping can be caused by interference, overinterrogation of beacon, **antenna nulls,** or pattern minimums.

beacon stealing. Loss of **beacon tracking** by one **radar** due to (interfering) **interrogation** signals from another radar.

beacon tracking. The **tracking** of a moving object by means of signals emitted from a transmitter or **transponder** within or attached to the object.

bead. See **lunar crater,** note.

beam. **1.** A ray or collection of focused rays of radiated energy. See **beam width, radiation pattern.** **2.** A beam (sense 1) of radio waves used as a navigation aid. **3.** = **electron beam.** **4.** A body, one of whose dimensions is large compared with the others, whose function is to carry lateral loads (perpendicular to the long dimension) and bending movements.

beam angle = **beam width.**

beam-climber guidance = **beam-rider guidance.**

beam rider. A craft following a **beam,** particularly one which does so automatically, the beam providing the **guidance.**

beam-rider guidance. A system for guiding aircraft or spacecraft in which a craft follows a radar beam, light beam, or other kind of **beam** along the desired path. Also called *beam-climber guidance.* See **guidance.**

beam riding. The maneuver of a spacecraft or other vehicle as it follows a **beam.**

beam splitter. A partially reflecting mirror which permits some **incident** light to pass through and reflects the remainder.

beam-switching tube. A **trochotron** in which an **electron beam** can be formed and switched to any one of several (usually 10) positions.

Beam switching tubes are used in computers.

beam width. A measure of the concentration of power of a **directional antenna.** It is the angle in degrees subtended at the antenna by arbitrary power-level points across the axis of the **beam.** This power level is usually the point where the **power density** is one-half that which is present in the axis of the beam at the same distance from the antenna (half-power points). Also called *beam angle.*

The beam width of a radar determines the minimum angular separation which two targets can have and still be resolved. Roughly speaking, two targets at the same range whose angular separations at the radar antenna exceeds one-half of the beam width between half-power points will be resolved or distinguishable as two individual targets. The smaller the beam width, the greater the angular resolving power. Beam width may be at different locations through the axis depending upon the shape of the antenna reflector.

bearing. The horizontal direction of an object or point, usually measured clockwise from a reference line or direction through 360°.

A bearing is often designated as *true, magnetic, compass, grid,* or *relative* as the reference direction is true, magnetic, compass, or grid north, or heading, respectively.

At one time *bearing* was restricted to reference to the direction of a terrestrial object or point as distinguished from *azimuth* which referred to the direction of a celestial body. This distinction has been blurred by usage.

bearing angle. Horizontal direction measured from 0° at the reference direction clockwise or counterclockwise through 90° or 180°. Compare **bearing.**

Bearing angle is labeled with the reference direction as a prefix and the direction of measurement from the reference direction as a suffix. Thus, bearing angle N 37° W is 37° west of north, or bearing 323°.

beat. **1.** One complete **cycle** of the variations in the **amplitude** of two or more periodic phenomena of different frequency which mutually react. See **beat frequency.** **2.** To produce **beating.**

beat-beat Dovap = **Dovap elsse.**

beat frequency. The **frequency** obtained when two simple **harmonic** quantities of different frequencies f_1 and f_2 are superimposed. The *beat frequency* equals $f_1 - f_2$.

beating. A **wave** phenomenon in which two or more periodic quantities of different **frequencies** produce a resultant having pulsations of **amplitude.**

This process may be controlled to produce a desired **beat frequency.** See **heterodyne.**

beavertail antenna. A type of radar **antenna** which forms a beam having a greater **beam width** in azimuth than in elevation, or vice versa. In physical dimensions, its long axis lies in the plane of smaller beam width.

bediasite. See **tektite.**

Beer law = **Bouguer law.**

behavior. The way in which an organism, organ, body, or substance acts in an **environment** or responds to excitation, as *the behavior of steel under stress,* or *the behavior of an animal in a test.*

bel. The fundamental division of a **logarithmic scale** for expressing the ratio of two amounts of

power, the number of bels denoting such a ratio being the logarithm to the base 10 of this ratio.

With P_1 and P_2 designating two amounts of power and N the number of bels denoting their ratio, $N = \log_{10} (P_1/P_2)$ bels.

Bemporad formula. A formula for the optical air mass m in terms of the **zenith distance** z of the sun or other celestial body:

$$m = R/58.36 \sec \sin z$$

where R is **astronomical refraction,** seconds of arc.

For values of z less than about 70°, the Bemporad formula can be replaced by the simpler approximate formula,

$$m = \sec z$$

bends. **1.** Pains in the extremities, abdomen, and chest caused by **aeroemphysema** and in some instances by **aeroembolism** resulting from the reduction of ambient air pressure. **2.** Popularly used as synonymous with *aeroembolism* (sense **2**).

Bernoulli law or **Bernoulli theorem.** (After Daniel Bernoulli, 1700–1782, Swiss scientist.) **1.** In aeronautics, a law or theorem stating that in a flow of incompressible fluid the sum of the **static pressure** and the **dynamic pressure** along a **streamline** is constant if gravity and frictional effects are disregarded.

From this law it follows that where there is a velocity increase in a fluid flow there must be a corresponding pressure decrease. Thus an airfoil, by increasing the velocity of the flow over its upper surface, derives lift from the decreased pressure.

2. As originally formulated, a statement of the **conservation of energy** (per unit mass) for a nonviscous fluid in steady motion. The specific energy is composed of the kinetic energy $u^2/2$, where u is the speed of the fluid; the potential energy gz, where g is the acceleration of gravity and z is the height above an arbitrary reference level; and the work done by the pressure forces of a compressible fluid $\int v\,dp$, where p is the pressure, v is the specific volume, and the integration is always with respect to values of p and v on the same parcel. Thus, the relationship

$$\frac{v^2}{z} + gz + \int v\,dp = \text{Constant along a streamline}$$

is valid for a compressible fluid in steady motion, since the streamline is also the path. If the motion is also irrotational, the same constant holds for the entire fluid.

Besselian star numbers. Constants used in the reduction of a **mean position** of a star to an **apparent position** (used to account for short-term variations in the **precession, nutation, aberration,** and **parallax**).

Besselian year = **fictitious year.**

Bessel fictitious year = **fictitious year.**

beta decay. Radioactive transformation of a **nuclide** in which the **atomic number** changes by ±1 with the emission of a **beta particle** and the **mass number** remains unchanged. Also called *beta disintegration.*

Increase of atomic number occurs with negative beta particle emission, decrease with positive beta particle (positron) emission or upon electron capture.

beta disintegration = **beta decay.**

beta factor, β-factor. In **plasma physics,** the ratio of the plasma kinetic pressure to the **magnetic pressure.**

If β is less than 1, the magnetic field has a chance to contain the plasma providing there are no instabilities. If β is larger than 1, there is no possible chance of containment.

beta ray, β-ray. A stream of **beta particles.**

betatron. A **particle accelerator** in which magnetic induction is used to accelerate **electrons.**

Betatron refers to the accelerated particles, electrons, which are identical with **beta particles.**

bias error. A measurement error that remains constant in magnitude for all observations. A kind of **systematic error.**

An example is an incorrectly set zero adjustment.

bidirectional transducer. A **transducer** device capable of measuring input in both a positive and a negative direction from a reference zero or rest position.

bilateral transducer. A **transducer** capable of transmission simultaneously in both directions.

billiard-ball collision = **elastic collision.**

billitonite. See **tektite.**

bimetallic strip gage. A thermal conductivity **vacuum gage** in which deflection of a bimetallic strip with changing temperature indicates the changes in pressure.

binary. **1.** Involving the integer two (2). See **binary notation.** **2.** = **binary cell.** **3.** = **binary star.**

binary cell. Any device or circuit that can be placed in either of two stable states to store a **bit** of binary information. Often called a *binary.*

binary chain. A cascaded series of **binary cells.**

binary code. A code composed of a combination of entities each of which can assume one of two possible states. Each entity must be identifiable in time or space.

binary counter. A **counter** with two distinguishable states.

binary device = **binary cell.**

binary digit. A **digit** (0 or 1) in **binary notation.** See **bit.**

binary magnetic core. A ferromagnetic material which can be caused to assume either of two stable magnetic states and thus can be used in a **binary cell.**

binary notation. A system of **positional notation** in which the **digits** are coefficients of powers of the base 2 in same way as the digits in the conventional decimal system are coefficients of powers of the base 10.

Binary notation employs only two digits, 1 and 0, therefore is used extensively in computers where the *on* and *off* positions of a switch or storage device can represent the two digits.

In decimal notation $111 = (1 \times 10^2) + (1 \times 10^1) + (1 \times 10^0) = 100 + 10 + 1 =$ one hundred and eleven.

In binary notation $111 = (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 4 + 2 + 1 =$ seven.

binary number system. See **binary notation.**

binary point. The **base point** in **binary notation.**

binary star. A system of two stars revolving about their **barycenter.**

The smaller star of the system is referred to as the *companion* or *comes*.

Visible binaries are those which can be resolved into two stars by a telescope.

Spectroscopic binaries are those which cannot be resolved by a telescope but show temporary displacement and doubling of the lines in their spectra.

binding energy. 1. The force which holds molecules, atoms, or atomic particles together; specifically, the force which holds an atomic **nucleus** together. **2.** The energy required to break chemical, atomic, or molecular bonds.

bioastronautics. The study of biological, behavioral, and medical problems pertaining to **astronautics.** This includes systems functioning in the **environments** expected to be found in space, vehicles designed to travel in space, and the conditions on celestial bodies other than on earth.

biochemistry. Chemistry dealing with the chemical processes and compounds of living organisms.

bioclimatology. The study of the relations of climate and life, especially the effects of climate on the health and activity of human beings (human bioclimatology) and on animals and plants.

biodynamics. The study of the effects of dynamic processes (motion, **acceleration, weightlessness,** etc.) on living organisms.

bionics. The study of systems, particularly **electronic** systems, which function after the manner of, or in a manner characteristic of, or resembling, living systems.

biopak. A container for housing a living organism in a habitable **environment** and for recording biological functions during space flight.

biosatellite. An artificial **satellite** which is specifically designed to contain and support man, animals, or other living material in a reasonably normal manner for an adequate period of time and which, particularly for man and animals, possesses the proper means for safe return to the earth. See **ecological system.**

biosensor. A **sensor** used to provide information about a life process.

biosphere. That transition zone between earth and **atmosphere** within which most forms of terrestrial life are commonly found; the outer portion of the **geosphere** and inner or lower portion of the atmosphere. See **hydrosphere.**

biotechnology. The application of engineering and technological principles to the life sciences.

biotelemetry. The remote measuring and evaluation of life functions, as, e.g., in **spacecraft** and artificial **satellites.**

biotron. A **test chamber** used for biological research within which the environmental conditions can be completely controlled, thus allowing observations of the effect of variations in **environment** on living organisms.

bipropellant. A rocket **propellant** consisting of two unmixed or uncombined chemicals (**fuel** and **oxidizer**) fed to the combustion chamber separately.

bipropellant rocket. A **rocket** using two separate **propellants** which are kept separate until mixing in the **combustion chamber.**

biquinary notation. A numerical system in which each **decimal digit** is represented by a pair of digits consisting of a coefficient of five followed by a coefficient of one.

For example, the decimal digit 7 is represented in biquinary notation by $12[(1 \times 5) + (2 \times 1)]$, and the decimal quantity 3648 is represented by 03 11 04 13. The abacus is based on biquinary notation.

bird. A colloquial term for a **rocket, satellite,** or **spacecraft.**

bistable elements. In computer terminology, a device which can remain indefinitely in either of two stable states.

bistable multivibrator. A multivibrator which can exist indefinitely in either of two stable states. Also called *flip-flop*.

bistatic reflectivity. The characteristic of a **reflector** which reflects energy along a line, or lines, different from, or in addition to, that of the **incident ray.**

For example, any reflector that **scatters** the incident energy.

bit. 1. An abbreviation of *b*inary dig*it*. 2. A single character of a language employing only two distinct kinds of characters. 3. A quantity of intelligence which is carried by an identifiable entity and which can exist in either of two states. 4. A unit of **storage capacity;** the capacity in bits of a storage device is the logarithm to the base two of the number of possible states of the device. 5. A **quantum** of information. 6. Loosely, a mark.

bit rate. The frequency derived from the period of time required to transmit one **bit.**

black body, blackbody (*symbol* ***b*** used as subscript). 1. An ideal emitter which radiates energy at the maximum possible rate per unit area at each wavelength for any given temperature. A black body also absorbs all the radiant energy in the near visible spectrum incident upon it.

No actual substance behaves as a true black body, although platinum black and other soots rather closely approximate this ideal. However, one does speak of a black body with respect to a particular wavelength interval. This concept is fundamental to all the **radiation laws,** and is to be compared with the similarly idealized concepts of the **white body** and the **gray body.** In accordance with the **Kirchoff law,** a black body not only absorbs all wavelengths, but emits at all wavelengths and does so with maximum possible intensity for any given temperature.

2. A laboratory device which simulates the characteristics of a **black body** (sense 1). See **hohlraum.**

black-body emission = **black-body radiation.**

black-body radiation. The **electromagnetic radiation** emitted by an ideal **black body;** it is the theoretical maximum amount of radiant energy of all wavelengths which can be emitted by a body at a given temperature.

The spectral distribution of black-body radiation is described by **Planck law** and the related **radiation laws.** If a very tiny opening is made into an otherwise completely enclosed space (hohlraum), the radiation passing out through this hole when the walls of the enclosure have come to thermal equilibrium at some temperature will closely approximate ideal black-body radiation for that temperature.

black box. 1. In engineering design, a unit whose **output** is a specified function of the **input,** but for which the method of converting input to output is not necessarily specified. 2. Colloquially, any unit, usually an electronic device such as an amplifier, which can be mounted in, or removed from, a rocket, spacecraft, or the like as a single package.

blackout. 1. A **fadeout** of radio communications due to ionospheric disturbances.

Blackouts are most common in, but are not restricted to, the arctic. An arctic blackout may last for days or even weeks during periods of intense auroral activity. Recent experiments with high-altitude nuclear detonations have produced blackouts and artificial auroras over the subtropics.

2. A fadeout of radio and telemetry transmission between ground stations and vehicles travelling at high speeds in the atmosphere caused by signal attenuation in passing through ionized boundary layer (**plasma sheath**) and shock wave regions generated by the vehicle.

3. A vacuum tube characteristic which results from the formation of a **dielectric** film on the surface of the control grid.

A negative charge, accumulated on the film when the grid is driven positive with respect to the cathode, affects the operating characteristics of the tube.

4. A condition in which vision is temporarily obscured by a blackness, accompanied by a dullness of certain of the other senses, brought on by decreased blood pressure in the eye and a consequent lack of oxygen, as may occur, e.g., in pulling out of a high-speed dive in an airplane. Compare **grayout, redout.**

blade. 1. (a) An arm of a propeller; a rotating wing. (b) Specifically, restrictive, that part of a propeller arm or of a rotating wing from the shank outward, i.e., that part having an efficient airfoil shape and that cleaves the air. See **blade shank.** 2. A **vane** (in sense 2), such as a rotating vane or stationary vane in a rotary air compressor, or a vane of a turbine wheel.

blanket. To blank out or obscure weak radio signals by a stronger signal.

blank-off pressure. See **ultimate pressure.**

blast. 1. The brief and rapid movement of air or other fluid away from a center of outward pressure, as in an explosion. 2. The characteristic instantaneous rise in **pressure,** followed by a sudden decrease, that results from this movement, differentiated from less rapid pressure changes. 3. To **take off** from a launching pad or stand. Said of a rocket in reference to the blast effects caused by rapid combustion of fuel as the rocket starts to move upward. (Popular.)

This term is commonly used for *explosion*, but the two terms should be distinguished. In space, an explosion could take place, but no blast would follow.

blast chamber. A **combustion chamber,** especially a combustion chamber in a gas-turbine engine, jet engine, or rocket engine.

blast deflector. A device used to divert the exhaust of a **rocket** fired from a vertical position.

blastoff. A missile **launch.** (Slang.)

blast vane = **jet vane.**

Blaton formula. In meteorology, an expression relating the curvature of the **trajectory** K_t of a **fluid parcel** to the **streamline** K_s

$$K_t = K_s - (1/v)\ (\partial\psi/\partial t)$$

where v is the parcel speed, $\partial\psi/\partial t$ is the local change of wind direction, ψ is the wind angle, and t is time. The curvatures and change of wind direction are positive for **cyclonic** flow.

bleed. To let a fluid, such as air or liquid oxygen, escape from a pipe, tank, or the like.

bleed off. To take off a part or all of a fluid from a tank or line, normally through an escape valve or outlet, as in *to bleed off excess oxygen from a tank.*

blip. A spot of light or deflection of the **trace** on a radarscope, loran indicator, or the like, caused by the received signal, as from a reflecting object. Also called a *pip* or *echo.*

blob. A fairly small-scale temperature and moisture inhomogeneity produced by **turbulence** within the atmosphere.

The abnormal gradient of the **index of refraction** resulting from a *blob* can produce a radar echo of the type known as *angels*.

block. In computer operations, a group of **machine words** considered as a unit.

blockhouse, block house. **1.** A reinforced concrete structure, often built underground or half underground, and sometimes dome shaped, to provide protection against blast, heat, or explosion during rocket launchings or related activities; specifically, such a structure at a **launch site** that houses electronic control instruments used in launching a rocket. **2.** The activity that works in such a structure.

blocking oscillator. A regenerative circuit which generates **pulses** of short duration.

Blocking oscillators are used in **digital computers.**

blowdown tunnel. A type of **wind tunnel** in which stored compressed gas is allowed to expand through a test section to provide a stream of gas or air for model testing.

The downstream side may or may not be reduced in pressure to provide greater expansion potential.

blowdown turbine. A **turbine** attached to a **reciprocating engine** which receives exhaust gases separately from each cylinder, utilizing the kinetic energy of the gases.

blowoff. The action of applying an explosive force and separating a package section away from the remaining part of a **rocket vehicle** or **reentry body,** usually to retrieve an instrument or to obtain a record made during early flight. See **fallaway section.**

blue-sky scale = **Linke scale.**

bluff body. A body having a broad, flattened front, as in some **reentry vehicles.**

bluntness (*symbol* B). A parameter of a **conic** related to the **eccentricity,** e, of the conic in the following way:

For hyperbolas and prolate ellipses,

$$B = 1 - e^2$$

For oblate ellipses,

$$B = 1/(1 - e^2)$$

boattail. The rear portion of an elongated body, as a rocket, having decreasing cross-sectional area toward the rear.

bobbing. Fluctuation of the strength of a radar **echo,** or its indication on a **radarscope,** due to alternate interference and reinforcement of returning reflected waves.

body. **1.** The main part or main central portion of an airplane, airship, rocket, or the like; a fuselage or hull. **2.** In a general sense, any fabrication, structure, or other material form, especially one aerodynamically or ballistically designed, as, *an airfoil is a body designed to produce an aerodynamic reaction.*

body angle. The angle which the **longitudinal axis** of the **airframe** makes with some selected line.

body axis. Any one of a system of mutually perpendicular reference axes fixed in an aircraft or similar body and moving with it. See **axis.**

body of revolution. A symmetrical body having the form described by rotating a plane curve about an **axis** in its plane.

bogie. **1.** A supporting and alining wheel or roller on the inside of an endless track, used, e.g., in certain types of **landing gear.** **2.** A type of landing-gear unit consisting of two sets of wheels in tandem with a central strut.

Bohr magneton, electronic Bohr magneton (*symbol* μ_B). A constant equivalent to the magnetic moment of an electron, 9.27372×10^{-21} erg/gauss. See **physical constants,** tables.

Bohr magneton is sometimes used as a synonym for nuclear magneton, which see.

Bohr radius (*symbol* a_0). The smallest possible radius of an electron orbit in the Bohr model of the atom, 5.29167×10^9 centimeters.

boilerplate model. A metal copy of a flight vehicle, the structure or components of which are heavier than the flight model.

boiling point (*abbr* **bp**). The temperature at which the **equilibrium vapor pressure** between a liquid and its vapor is equal to the external pressure on the liquid. Compare **ice point.**

boiloff. The vaporization of a liquid, such as liquid oxygen or liquid hydrogen, as its tem-

perature reaches its **boiling point** under conditions of exposure, as in the tank of a rocket being readied for launch.

bolide. A brilliant **meteor,** especially one which explodes; a detonating **fireball.**

bologram. The record obtained from a **bolometer.**

bolometer. An instrument which measures the intensity of radiant energy by employing a thermally sensitive electrical resistor; a type of **actinometer.** Also called *actinic balance.* Compare **radiometer.**

Two identical, blackened, thermally sensitive electrical resistors are used in a Wheatstone bridge circuit. Radiation is allowed to fall on one of the elements, causing a change in its resistance. The change is a measure of the intensity of the radiation.

bolometric magnitude. 1. The **magnitude** of a star for the entire **electromagnetic spectrum** without atmospheric absorption.

The magnitude measured within the earth's atmosphere by a bolometer is the *radiometric magnitude.*

2. Loosely = **radiometric magnitude.**

Boltzmann constant (*symbol* ***k***). The ratio of the **universal gas constant** to **Avogadro number;** equal to 1.38054×10^{-16} erg/°K. Sometimes called *gas constant per molecule, Boltzmann universal conversion factor.*

Boltzmann universal conversion factor = **Boltzmann constant.**

Bond albedo. The ratio of the amount of light reflected from a sphere exposed to parallel light to the amount of light incident upon it. Sometimes shortened to *albedo.*

The Bond albedo is used in planetary astronomy.

bonding. 1. Specifically, a system of connections between all metal parts of an aircraft or other structure forming a continuous electrical unit and preventing jumping or arcing of static electricity. **2.** Glueing or cementing together for structural strength.

Boo, Boot. International Astronomical Union abbreviation for *Bootes.* See **constellation.**

Boolean algebra. The study of the manipulation of symbols representing operations according to the rules of logic.

Boolean algebra corresponds to an algebra using only the numbers 0 and 1, therefore can be used in programming digital computers which operate on the **binary** principle.

boost. 1. Additional power, pressure, or force supplied by a **booster,** as, hydraulic boost, or extra propulsion given a flying vehicle during lift-off, climb, or other part of its flight as with a booster engine. **2. Boost pressure. 3.** To supercharge. **4.** To **launch** or to push along during a portion of flight, as *to boost a ramjet to flight speed by means of a rocket,* or *a rocket boosted to altitude with another rocket.*

booster. 1. Short for **booster engine** or **booster rocket. 2.** = **launch vehicle.**

booster engine. An engine, especially a **booster rocket,** that adds its thrust to the thrust of the **sustainer engine.**

booster pump. A pump in a fuel system, oil system, or the like, used to provide additional or auxiliary pressure when needed or to provide an initial pressure differential before entering a main pump, as in pumping hydrogen near the boiling point.

booster rocket. 1. A **rocket motor,** either solid or liquid, that assists the normal propulsive system or **sustainer engine** of a rocket or aeronautical vehicle in some phase of its flight. **2.** A rocket used to set a vehicle in motion before another engine takes over.

In sense 2 the term *launch vehicle* is preferred.

booster vehicle = **launch vehicle.**

boostglide vehicle. A **vehicle** designed to glide in the atmosphere following a rocket-powered phase. Portions of the flight may be **ballistic,** out of the atmosphere.

boost pressure. Manifold pressure greater than the ambient **atmospheric** pressure, obtained by supercharging. Often called *boost.*

Bootes (*abbr* **Boo, Boot**). See **constellation.**

bootstrap. 1. Referring to a self-generating or self-sustaining process; specifically, the operation of liquid-propellant rocket engines in which, during main-stage operation, the gas generator is fed by the main propellants pumped by the turbopump, and the turbopump in turn is driven by hot gases from the gas generator system.

Such a system must be started in its operation by outside power or propellants. When its operation is no longer dependent on outside power or propellant the system is said to be in *bootstrap* operation.

2. In computer operations, the coded instructions at the beginning of an input tape which together with manually inserted instructions, initiate a **routine. 3.** = **leap-frog.** See, **leapfrog test.**

boresight camera. A camera mounted in the optical axis of a **tracking radar** to photograph rockets being tracked while in camera range and thus provide a correction for the alinement of the radar.

boresight error. The linear displacement between two parallel lines of sight.

boresighting. In radio the process of alining a **directional antenna** system by an optical procedure.

Bose-Einstein statistics. Formulas relating to **equations of state** and partition of **kinetic energy** when the wave functions are symmetric.

Bouguer law. A relationship describing the rate of decrease of flux density of a plane-parallel beam of **monochromatic** radiation as it penetrates a medium which both scatters and absorbs at that wavelength. This law may be expressed

$$dI_\lambda = -\alpha_\lambda I_\lambda \, dx$$

or

$$I_\lambda = I_{\lambda 0} e^{-\alpha_\lambda x}$$

where I is the flux density of the radiation; α_λ is the **attenuation coefficient** (or extinction coefficient) of the medium at wavelength λ; $I_{\lambda 0}$ is the flux density at the source; and x is the distance from the source. Sometimes called *Beer law, Lambert law of absorption.* See **absorption coefficient, scattering coefficient.**

bounce table. A testing device which subjects devices and **components** to impacts such as might be encountered in accidental dropping.

boundary conditions. A set of mathematical conditions to be satisfied, in the solution of a differential equation, at the edges or physical boundaries (including fluid boundaries) of the region in which the solution is sought. The nature of these conditions usually is determined by the physical nature of the problem. See **boundary-value problem.**

boundary layer. The layer of **fluid** in the immediate vicinity of a bounding surface; in fluid mechanics, the layer affected by viscosity of the fluid, referring ambiguously to the *laminar boundary layer*, *turbulent boundary layer*, *planetary boundary layer*, or *surface boundary layer.*

In aerodynamics the boundary-layer thickness is measured from the surface to an arbitrarily chosen point, e.g., where the velocity is 99 percent of the stream velocity. Thus, in aerodynamics, *boundary layer* by selection of the reference point, can include only the laminar boundary layer or the laminar boundary layer plus all, or a portion of, the turbulent boundary layer.

boundary-value problem. A physical problem completely specified by a differential equation in an unknown, valid in a certain region of space, and certain information (**boundary condition**) about the unknown, given on the boundaries of that region. The information required to determine the solution depends completely and uniquely on the particular problem. See **initial-value problem.**

Boussinesq approximation. The assumption (frequently used in the theory of **convection**) that the fluid is incompressible except insofar as the thermal expansion produces a buoyancy, represented by a term $g\alpha T$, where g is the **acceleration of gravity;** α is the coefficient of thermal expansion; and T is the **perturbation temperature.**

bow wave. A **shock wave** in front of a body, such as an airfoil, or apparently attached to the forward tip of the body.

Boyle law = Boyle-Mariotte law.

Boyle-Mariotte law. The empirical generalization that for many so-called perfect gases, the product of pressure p and volume V is constant in an isothermal process:

$$pV = F(T)$$

where the function F of the temperature T cannot be specified without reference to other laws (e.g., **Charles-Gay-Lussac law**). Also called *Boyle law, Mariotte law.*

brake parachute = deceleration parachute.

braking ellipses. A series of ellipses, decreasing in size due to **aerodynamic drag,** followed by a **spacecraft** in entering a planetary atmosphere.

In theory, this maneuver will allow a spacecraft to dissipate the heat generated in entry without burning up.

braking rocket = retrorocket.

branch. 1. In an electrical circuit, a portion of a **network** consisting of one or more two-terminal elements in series. 2. The point in a **computer** program at which the machine will proceed with one of two or more possible **routines** according to existing conditions and instructions.

branch point = node.

Brayton cycle. (After George B. Brayton, American engineer.) Same as **Joule cycle.**

brazing. Joining metals by flowing a thin-layer capillary thickness of nonferrous filler metal into the space between them.

Bonding results from the intimate contact produced by the dissolution of a small amount of base metal in the molten filler metal, without fusion of the base metal. *Sometimes, the filler metal is put in place as a thin solid* sheet or as *cladding* and the composite is heated as in *furnace brazing.*

The term *brazing* is used where the temperature exceeds some arbitrary value, such as 800° F; the term *soldering* is used for temperatures lower than the arbitrary value.

breadboard. 1. An assembly of preliminary circuits or parts used to prove the feasibility of a device, circuit, system, or principle without regard to the final configuration or packaging of the parts. 2. To prepare a *breadboard*, sense 1.

breakaway. The action of a **boundary layer** separating from a surface.

breakaway phenomenon. See **breakoff phenomenon.**

breakdown potential = dielectric strength.

breakoff = **breakoff phenomenon.**

breakoff phenomenon. The feeling which sometimes occurs during high-altitude flight of being totally separated and detached from the earth and human society. Also called the *breakaway phenomenon.*

break point. In computer operations, a point at which a **break-point instruction** inserted in the **routine** will cause the machine to stop, upon a command from the operator, for a check of progress.

break-point instruction. In computer operations, an instruction which, in conjunction with a manually operated control, causes the machine to stop.

bremsstrahlung (German, *braking radiation*). **Electromagnetic radiation** produced by the rapid change in the velocity of an electron or another fast, charged **particle** as it approaches an atomic **nucleus** and is deflected by it. See **bremsstrahlung effect.**

bremsstrahlung effect. The **emission** of **electromagnetic radiation** as a consequence of the acceleration of charged elementary **particles,** such as electrons, under the influence of the attractive or repulsive force fields of atomic nuclei near which the charged particle moves.

In cosmic-ray shower production, bremsstrahlung effects give rise to emission of gamma rays as electrons encounter atmospheric nuclei. The emission of radiation in the bremsstrahlung effect is merely one instance of the general rule that electromagnetic radiation is emitted only when electric charges undergo acceleration.

brennschluss. (German, *combustion termination.*) The cessation of burning in a **rocket,** resulting from consumption of the propellants, from deliberate shutoff, or from other cause; the time at which this cessation occurs. See **burnout, cutoff.**

Brewster point. One of the three commonly detectable points of zero polarization of **diffuse sky radiation,** neutral points, along the vertical circle through the sun; the other two are the **Arago point** and **Babinet point.**

This neutral point, discovered by Brewster in 1840, is located about 15° to 20° directly below the sun; hence it is difficult to observe because of the glare of the sun.

brightness. 1. The attribute of visual perception in accordance with which an area appears to emit more or less light. **2.** = **luminance.**

In sense 2 *luminance* is preferred.

brightness level = **adaptation luminance.**

brightness temperature. 1. In astrophysics, the **temperature** of a **black body** radiating the same amount of energy per unit area at the wavelengths under consideration as the observed body. Compare **effective temperature, antenna temperature. 2.** The temperature of a nonblack body determined by measurement with an optical **pyrometer.**

Brinell hardness number (*abbr* **Bhn**). A parameter describing the hardness of a material as the ratio of pressure on a standard sphere used to indent the material to be tested to the area of the indentation produced.

British candle = **international candle.**

British thermal unit (*abbr* **Btu**). The amount of heat required to raise 1 pound of water at 60° F, 1° F.

This unit is defined for various temperatures, but the general usage seems to be to take the Btu as equal to 252 15° gram-calories or 1055 joules.

broadside array. An **antenna array** whose direction of maximum radiation is perpendicular to the line or plane of the array according as the elements lie on a line or plane. A uniform broadside array is a **linear array** whose elements contribute fields of equal **amplitude** and **phase.**

brush discharge = **corona discharge.**

B-scan = **B-display.**

B-scope. A cathode-ray indicator in which a signal appears as a spot with bearing as the horizontal coordinate and distance as the vertical coordinate. Also called *B-display.*

B-station. In **loran,** the designation applied to the transmitting station of a pair, the signal of which always occurs more than half a repetition period after the next succeeding signal and less than half a repetition period before the next preceding signal from the other station of the pair, designated an **A-station.**

B-trace. The second trace of an **oscilloscope** having more than one, as the lower trace of a loran indicator.

Btu (*abbr*). ***British thermal unit.***

buckling. 1. An unstable state of equilibrium of a thin-walled body stemming from compressive stresses in the walls. **2.** The lateral deflection of a thin-walled body resulting from such instability.

buffer. In computers: **1.** An isolating **circuit** used to avoid reaction of a driven circuit on the corresponding driving circuit. **2.** A **storage device** used to compensate for a difference in rate of flow of information or time or occurrence of events when transmitting information from one device to another.

buffer storage. In computer operations, **storage** used to compensate for a difference in rate of flow or time of occurrence when transferring information from one device to another.

buffeting. The beating of an aerodynamic structure or surfaces by unsteady flow, gusts, etc.; the irregular shaking or oscillation of a vehicle component owing to turbulent air or separated flow.

build. Of a radiant energy signal, to increase, often temporarily, in received **signal strength** without a change of receiver controls.

The opposite is *fade*.

bulkhead. A wall, partition, or similar member in a rocket, spacecraft, airplane fuselage, or similar structure, at right angles to the **longitudinal axis** of the structure, and serving to strengthen, divide, or help give shape to the structure.

bulk modulus. The reciprocal of the **coefficient of compressibility.**

B-units. See **potential index of refraction.**

burble. A separation or breakdown of the **laminar flow** past a body; the eddying or **turbulent flow** resulting from this.

Burble occurs over an airfoil operating at an angle of attack greater than the angle of maximum lift, resulting in a loss of lift and an increase of drag. See **compressibility burble.**

burble angle = burble point.

burble point. A point reached in an increasing **angle of attack** at which **burble** begins. Also called *burble angle.*

burner = combustion chamber.

burn-in = debug.

burning rate (*symbol* **r**). The velocity at which a **solid propellant** in a **rocket** is consumed.

Burning rate is measured in a direction normal to the propellant surface and is usually expressed in inches per second.

burning rate constant (*symbol* **a**). A constant, related to initial grain temperature, used in calculating the **burning rate** of a rocket propellant **grain.**

burning-rate exponent (*symbol* **n**). The exponent n in the equation

$$r = ap_c^n$$

where r is **burning rate;** p_c is **chamber pressure;** and a and n are constants.

The value of n varies with the propellant.

burnout. 1. An act or instance of fuel or oxidant depletion or, ideally, the simultaneous depletion of both; the time at which this occurs. Compare **cutoff.**

In the United Kingdom *all burnt* is preferred to *burnout.*

2. An act or instance of something burning out or of overheating; specifically, an act or instance of a rocket combustion chamber, nozzle, or other part overheating so as to result in damage or destruction.

burnout velocity. The velocity of a **rocket,** rocket-powered aircraft, or the like at the time the fuel or oxidant or both are depleted. Also called *burnt velocity.*

burnt velocity = burnout velocity.

burnup. 1. In a **reactor,** the percentage of **fissionable** atoms that have been fissioned. 2. Depletion of reactor fuel by **fission.**

burst. 1. A single **pulse** of radio energy; specifically such a pulse at **radar** frequencies. 2. = **solar radio burst.** 3. = **cosmic ray burst.**

burst disk. A diaphragm designed to burst at a predetermined pressure differential; sometimes used as a valve, e.g., in a liquid-propellant line in a rocket. Also called a *rupture disk.*

bus. In computer operations, a main circuit, channel, or path for the transfer of information. Also called *trunk.*

Busch lemniscate. The locus in the sky, of all points at which the plane of polarization of diffuse sky radiation is inclined 45° to the vertical. Also called *neutral line.*

buzz. 1. In **supersonic diffuser** aerodynamics, a nonsteady shock motion and airflow associated with the shock system ahead of the inlet, very rapid pressure pulsations are produced which can affect downstream operation in the burner, nozzle, etc. 2. Sustained oscillation of an aerodynamic control surface caused by intermittent **flow** separation on the surface, or by a motion of **shock waves** across the surface, or by a combination of flow separation and shock-wave motion on the surface.

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C

Cae, Cael. International Astronomical Union abbreviations for *Caelum.* See **constellation.**

Caelum (abbr **Cae, Cael**). See **constellation.**

cage. To lock a **gyro** in a fixed position in its case.

caging. The process of orienting and mechanically locking the spin axis of a **gyro** to an internal reference position.

caisson disease. Those conditions including collapse, neurological changes, and pain, associated with relatively rapid reduction of ambient pressure from levels appreciably higher than 1 atmosphere to 1 atmosphere; and due to the release of inert gases in the body. Also called *compressed air illness, bends.*

calculating punch. A punched-card machine in which information is read from cards, and the results of sequential operations are punched on cards as they pass through the machine.

calendar. An orderly arrangement of days, weeks, months, etc. to suit a particular need such as civil life. See **Julian Day.**

calendar day. The period from midnight to midnight. The calendar day is 24 hours of **mean solar time** in length and coincides with the **civil day** unless a time change occurs during the day.

calendar year. The year of the **Gregorian calendar,** common years having 365 days and leap years 366 days.

Each year exactly divisible by 4 is a leap year, except century years (1800, 1900, etc.), which must be exactly divisible by 400 (2000, 2400, etc.) to be leap years. The calendar year is based on the **tropical year.** Also called *civil year.*

calibration marker. In radar, a calibration mark on the **display** to delineate bearing, distance, height, or time.

Callipic cycle. Four **Metonic cycles** or 76 years.

Callisto. A satellite of Jupiter orbiting at a mean distance of 1,884,000 kilometers. Also called *Jupiter IV.*

call number. In computer operations, a set of characters identifying a **subroutine** and containing (a) information concerning parameters to be inserted in the subroutine, (b) information to be used in generating the subroutine, or (c) information related to the **operands.**

calorie (*abbr* **cal**). A unit of **heat** originally defined as the amount of heat required to raise the temperature of 1 gram of water through 1° C (the gram-calorie or small calorie).

Several calories are now in use: International Steam Table calorie = 4.1868 joules, mean calorie = 4.19002 joules, thermochemical calorie = 4.184 joules, 15° C calorie = 4.18580 joules, 20° C calorie = 4.1890 joules. The kilogram calorie or kilocalorie is 1000 times as large as a calorie.

calorimeter. An instrument designed to measure **heat** evolved or absorbed.

Calorimeters are used in some **pyrheliometers.**

Cam, Caml. International Astronomical Union abbreviations for *Camelopardus.* See **constellation.**

Camelopardus (*abbr* **Cam, Caml**). See **constellation.**

Caml. International Astronomical Union abbreviation for *Camelopardus.* See **constellation.**

canard. Pertaining to an **aerodynamic vehicle** in which horizontal surfaces used for trim and control are forward of the main lifting surface; the horizontal trim and control surfaces in such an arrangement.

Canc. International Astronomical Union abbreviation for *Cancer.* See **constellation.**

Cancer (*abbr* **Cnc, Canc**). See **constellation.**

candela. The unit of luminous intensity in the International System of Units, 1960; equal to one-sixtieth of the luminous intensity from 1 square centimeter of a **black body** at 2046° K (the temperature of solidification of platinum). Also called *candle.*

candle = candela.

Canes Venatici (*abbr* **CVn, C Ven**). See **constellation.**

Canis Major (*abbr* **CMa, C Maj**). See **constellation.**

Canis Minor (*abbr* **CMi, C Min**). See **constellation.**

canonical time unit. For geocentric orbits, the time required by a hypothetical satellite to move one radian in a circular **orbit** of the earth's equatorial radius; 13.447052 minutes.

Cap, Capr. International Astronomical Union abbreviations for *Capricornus.* See **constellation.**

capability. A power or capacity to do something. Compare **characteristic.**

Capabilities belong to people, organized forces, or things.

capacity. In computer operations, (a) the largest quantity which can be stored, processed, or transferred; (b) the largest number of **digits** or characters which may regularly be processed; (c) the upper and lower limits of the quantities which may be processed.

Capr. International Astronomical Union abbreviation for *Capricornus.* See **constellation.**

Capricornus (*abbr* **Cap, Capr**). See **constellation.**

capsule. 1. A boxlike component or unit, often sealed. See **aneroid. 2.** A small, sealed, pressurized cabin with an internal **environment** which will support life in a man or animal during extremely high altitude flight, space flight, or emergency escape. See **ejection capsule.**

The term *spacecraft* is preferred to *capsule* for any man-carrying vehicle.

3. A container carried on a rocket or spacecraft, as an instrument *capsule* holding instruments intended to be recovered after a flight.

captive test. A **holddown test** of a propulsion subsystem, rocket engine or motor. Distinguished from a *flight test.*

capture. 1. Of a central force field, as of a planet; to overcome by gravitational force the velocity of a passing body and bring the body under the control of the **central force field,** in some cases absorbing its mass. **2.** Acquisition or absorption of an additional particle by an atomic **nucleus.**

capture effect. An effect in **frequency-modulation** (FM) reception where the stronger signal of two stations on the same frequency completely suppresses the weaker signal.

capturing. The use of a **torquer** to restrain the spin axis of a **gyro** to a specified position relative to the spin reference axis.

Car, Cari. International Astronomical Union abbreviations for *Carina.* See **constellation.**

carbide. A compound of carbon with one or more metallic elements.

carbon cycle. A sequence of atomic **nuclear** reactions and spontaneous **radioactive decay** which serves to convert matter into energy in the form of radiation and high-speed particles, and which is regarded as one of the principal sources of the energy of the sun and other similar stars.

This cycle, first suggested by Bethe in 1938, gets its name from the fact that carbon plays the role of a kind of catalyst in that it is both used by and produced by the reaction, but is not consumed itself. Four protons are, in net, converted into an alpha particle and two positrons (with accompanying neutrinos); and three gamma-ray emissions are emitted directly in addition to the two gamma emissions that ensue from annihilation of the positrons by ambient electrons. This cycle sets in at stellar interior temperatures of the order of 5 million degrees Kelvin.

An even simpler reaction, the **proton-proton** reaction, is also believed to occur within the sun and may be of equal or greater importance.

carcinogenesis. The origination or production of cancer.

card. 1. A punched card, used in **computer** operations for the storage of information in the form of holes punched through the card material.

Standard punched cards are 7.375 × 3.250 × 0.007 inches, containing either 80 columns in each of which any of 12 positions may be punched or 90 columns in each of which any combination of 6 places may be punched.

2. Any card adapted for the storage of information. **3.** A **printed-circuit** board, usually before other parts are mounted therein. See **module, package.**

cardiovascular. Pertaining to the heart and the blood vessels.

card punch. A mechanism which punches holes in **cards** used in **computer** operations.

An automatic card punch punches cards according to a stored program.

card reader. A mechanism that reproduces the information on punched **cards** in another form, usually electrical signals.

Cari. International Astronomical Union abbreviation for *Carina.* See **constellation.**

Carina (*abbr* **Car, Cari**). See **constellation.**

Carnot cycle. An idealized reversible **thermodynamic** cycle. The Carnot cycle consists of four stages: (a) an **isothermal** expansion of the gas at temperature T_1; (b) an **adiabatic** expansion to temperature T_2; (c) an isothermal compression at temperature T_2; (d) an adiabatic compression to the original state of the gas to complete the cycle. See **Carnot engine, thermodynamic efficiency.**

In a Carnot cycle, the net work done is the difference between the heat input Q_1 at higher temperature T_1 and the heat extracted Q_2 at the lower temperature T_2.

Carnot efficiency = thermodynamic efficiency.

Carnot engine. An idealized reversible **heat engine** working in a **Carnot cycle.** It is the most efficient engine that can operate between two specified temperatures; its efficiency is equivalent to the **thermodynamic efficiency.** The Carnot engine is capable of being run either as a conventional engine or as a refrigerator.

carrier. 1. In a **semiconductor,** a mobile conduction **electron** or **hole.** 2. In modulation of a signal, a **wave** suitable for being modulated as a sine wave, a recurring series of pulses, or a direct current.

carrier frequency. The **frequency** of a **carrier wave.**

carrier rocket. A **rocket** vehicle used to carry something, as in *the carrier rocket of the first artificial earth satellite.*

carrier wave (*abbr* **cw**). A **wave** generated at a point in the transmitting system and modulated by the **signal.**

carry time. In computer operations, the time required for a **binary chain** to complete its response to an input pulse.

Cartesian coordinates. A **coordinate system** in which the locations of points in space are expressed by reference to three planes, called coordinate planes, no two of which are parallel. Compare **curvilinear coordinates.**

The three planes intersect in three straight lines, called coordinate axes. The coordinate planes and coordinate axes intersect in a common point, called the origin. From any point P in space three straight lines may be drawn, each of which is parallel to one of the three coordinate planes. If A, B, C denote these points of intersection, the Cartesian coordinates of P are the distances PA, PB, and PC. If the coordinate axes are mutually perpendicular, the coordinate system is rectangular; otherwise, oblique.

Cas, Cass. International Astronomical Union abbreviations for *Cassiopeia.* See **constellation.**

cascaded. Of a series of elements or devices, arranged so that the **output** of one feeds directly into the **input** of another, as a series of **dynodes** or a series of **airfoils.**

The cascaded series usually serves to amplify the effect.

cascade shower. A group occurrence of **cosmic rays.** Also called *air shower.*

Cass. International Astronomical Union abbreviation for *Cassiopeia.* See **constellation.**

Cassegrain = Cassegrain telescope.

Cassegrainian telescope = Cassegrain telescope.

Cassegrain telescope. A reflecting telescope in which a small hyperboloidal mirror reflects the convergent beam from the paraboloidal primary mirror through a hole in the primary mirror to an eyepiece in back of the primary mirror. Also called *Cassegrainian telescope, Cassegrain.* See **Newtonian telescope.**

Cassiopeia (*abbr* **Cas, Cass**). See **constellation.**

catalogue = star catalogue.

catalogue number. The designation of a star by the name of a particular **star catalogue** and the number of the star in that catalogue.

catapult. A power-actuated machine or device for hurling forth something, as an airplane or missile, at a high initial speed; also, a device, usually explosive, for ejecting a person from an aircraft. Compare **launcher,** senses **1** and **2.**

catheter. A hollow tube of metal, glass, hard or soft rubber, rubberized silk, etc., for introduction into a body cavity through a narrow canal, for the purpose of discharging the fluid contents of a cavity or for establishing that the canal is unobstructed.

cathode. In an electron tube, an **electrode** through which a primary stream of electrons enters the interelectrode space. See **cold cathode, hot cathode** (thermionic cathode), **photocathode.**

cathode-ray indicator = cathode-ray oscilloscope.

cathode-ray oscillograph = cathode-ray oscilloscope.

cathode-ray oscilloscope. An instrument which displays visually on the face of a **cathode-ray tube** instantaneous voltages of electrical signals. Either the intensity or the displacement of the trace may be controlled by the signal voltage. More commonly called *oscilloscope.* Also called *cathode-ray oscillograph.* See **radarscope.**

cathode-ray tube (*abbr* **CRT**). A vacuum tube consisting essentially of an **electron gun** producing a concentrated electron beam (or cathode ray) which impinges on a phosphorescent coating on the back of a viewing face (or screen). The **excitation** of the **phosphor** produces light, the intensity of which is controlled by regulating the flow of electrons. Deflection of the beam is achieved either electromagnetically by currents in coils around the tube, or electrostatically by voltages on internal deflection plates.

cathode rays. Electrons that are driven from the negative electrode (the **cathode**) of a discharge tube.

cathode-ray screen. See **cathode-ray tube.**

catoptric light. A light concentrated into a parallel beam by means of a reflector.

A light so concentrated by means of refracting lenses or prisms is a dioptric light.

cat whisker. A fine wire **pickoff,** specifically a **gyro pickoff.**

Cauchy number. A nondimensional number arising in the study of the elastic properties of a fluid. It may be written $U^2\rho/E$, where U is a characteristic velocity; ρ is the density; and

E the modulus of elasticity of the fluid. It is the square of the **Mach number.**

cavitation. The formation of bubbles in a liquid, occurring whenever the **static pressure** at any point in the fluid flow becomes less than the fluid vapor pressure.

cavity heat receiver = **hohlraum.**

cavity resonator. See **resonator.**

C-band. See **frequency band.**

CED= Capacitance electronic discs

C-display. In radar, a rectangular **display** in which targets appear as **blips** with bearing indicated by the horizontal coordinate and angles of elevation by the vertical coordinate. Also called *C-scan* and *C-scope.*

celestial. **1.** Of or pertaining to the heavens. **2.** Short for *celestial navigation.*

celestial body. Any aggregation of matter in space constituting a unit for astronomical study, as the sun, moon, a planet, comet, star, nebula, etc. Also called *heavenly body.*

celestial coordinates. Any set of **coordinates** used to define a point on the **celestial sphere.**

The horizon, celestial equator, ecliptic, and galactic systems of celestial coordinates are based on the celestial horizon, celestial equator, ecliptic, and galactic equator, respectively, as the **primary great circle.** See **coordinate,** table VI, for a comparison of the systems.

celestial equator. The **primary great circle** of the **celestial sphere** in the **equatorial system,** everywhere 90° from the celestial poles; the intersection of the extended plane of the equator and the celestial sphere. Also called *equinoctial.*

celestial equator system of coordinates = **equatorial system.**

celestial guidance. The process of directing movements of an aircraft or spacecraft, especially in the selection of a **flight path,** by reference to celestial bodies. Also called *automatic celestial navigation.* See **guidance, celestial navigation.**

celestial horizon. That **great circle** of the **celestial sphere** formed by the intersection of the celestial sphere and a plane through the center of the earth and perpendicular to the zenith-nadir line. Also called *rational horizon.* See **horizon, horizon system.**

celestial-inertial guidance. The process of directing the movements of an aircraft or spacecraft, especially in the selection of a flight path, by an **inertial guidance** system which also receives inputs from observations of celestial bodies.

celestial latitude. Angular distance north or south of the **ecliptic;** the arc of a **circle of latitude** between the ecliptic and a point on the **celestial sphere,** measured northward or southward from the ecliptic through 90°, and labeled N or S to indicate the direction of measurement. See **ecliptic system of coordinates.**

celestial line of position. A **line of position** determined by observation of one (or more) celestial bodies.

celestial longitude. Angular distance east of the **vernal equinox,** along the **ecliptic;** the arc of the ecliptic or the angle at the ecliptic pole between the **circle of latitude** of the vernal equinox and the circle of latitude of a point on the celestial sphere, measured eastward from the circle of latitude of the vernal equinox, through 360°. See **ecliptic system of coordinates.**

celestial mechanics. The study of the theory of the motions of **celestial bodies** under the influence of gravitational fields. See **gravitation.**

celestial meridian. A **great circle** of the **celestial sphere,** through the celestial poles and the **zenith.**

The expression usually refers to the upper branch, that half of the great circle from pole to pole which passes through the zenith; the other half being the lower branch. The celestial meridian coincides with the **hour circle** through the zenith and the **vertical circle** through the elevated pole.

celestial navigation. The process of directing a craft from one point to another by reference to **celestial bodies** of known coordinates.

Celestial navigation usually refers to the process as accomplished by a human operator. The same process accomplished automatically by a machine is usually termed *celestial guidance* or sometimes *automatic celestial navigation.*

celestial observation. In navigation, the measurement of the **altitude** of a **celestial body,** or the measurement of **azimuth,** or measurement of both altitude and azimuth. Also called *sight.*

The expression may also be applied to the data obtained by such measurement.

celestial pole. Either of the two points of intersection of the **celestial sphere** and the extended axis of the earth, labeled *N* or *S* to indicate whether the *north celestial pole* or the *south celestial pole.*

celestial sphere. An imaginary sphere of infinite radius concentric with the earth, on which all **celestial bodies** except the earth are assumed to be projected.

celestial triangle. A spherical triangle on the **celestial sphere,** especially the **navigational triangle.**

cell. In computers, an elementary unit of **storage,** as *binary cell, decimal cell.*

Celsius temperature scale (*abbr* **C**). Same as **centigrade temperature scale.**

The Ninth General Conference on Weights and Measures (1948) replaced the designation *degree centigrade* by *degree Celsius.*

Cen, Cent. International Astronomical Union abbreviations for *Centaurus.* See **constellation.**

cent. In acoustics, the interval between two sounds whose basic **frequency ratio** is the twelve-hundredth root of 2.

Centaurus (*abbr* **Cen, Cent**). See **constellation.**

center frequency. The assigned **carrier frequency** of a **frequency-modulation** (FM) station; the unmodulated frequency of an FM system.

center of mass. That point in a given body, or in a system of two or more bodies that act together in respect to another body, which represents the mean position of the matter in the body or bodies. See **barycenter.**

center of thrust = **thrust axis.**

centi (*abbr* **C**). A prefix meaning one-hundredth.

centigrade temperature scale (*abbr* **C**). A temperature scale with the ice point at 0° and the boiling point of water at 100°. Now called *Celsius temperature scale.*

Conversion to the Fahrenheit temperature scale is according to the formula

$$°C = 5/9\ (°F - 32)$$

centimeter (*abbr* **cm**). One-hundredth of a meter; approximately 0.3937 U.S. inch, exactly 1/2.54 inch.

centimeter-gram-second system (*abbr* **cgs**). A system of units based on the centimeter as the unit of length, the gram as the unit of mass, and the second as the unit of time.

centimetric waves. See **frequency band.**

centipoise (*abbr* **cp**). A unit of **viscosity.** See **poise.**

central control. 1. Control exercised over an extensive and complicated system from a single center. **2.** Usually capitalized. The place, facility, or activity from which this control is exercised; specifically, at Cape Canaveral or at Vandenberg AFB, the place, facility, or activity at which the whole action incident to a test launch and flight is coordinated and controlled, from the make-ready at the launch site and on the range, to the end of the rocket flight downrange.

For a few seconds during the actual launch, control of a missile is exercised from the **blockhouse,** but it almost immediately reverts to Central Control for guidance and tracking, with two men in essential control. One of these is the supervisor of range operations, the other is the range safety officer.

central force. A **force** which for purposes of computation can be considered to be concentrated at one central point with its intensity at any other point being a function of the distance from the central point.

Gravitation is considered as a central force in celestial mechanics.

central force field. The spatial distribution of the influence of a **central force.**

centrifugal acceleration = **centrifugal force.**

centrifugal compressor. A **compressor** having one or more vaned rotary **impellers** which accelerate the incoming fluid radially outward into a **diffuser,** compressing by centrifugal force. Sometimes called a *centrifugal-flow compressor.* Compare **axial-flow compressor.**

centrifugal-flow compressor = **centrifugal compressor.**

centrifugal force. The **apparent force** in a rotating system, deflecting masses radially outward from the axis of rotation, with magnitude per unit mass $\omega^2 R$, where ω is the angular speed of rotation; and R is the radius of curvature of the path. This magnitude may also be written as V^2/R, in terms of the linear speed V. This force (per unit mass) is equal and opposite to the **centripetal acceleration.** Also called *centrifugal acceleration.*

The centrifugal force on the earth and atmosphere due to rotation about the earth's axis is incorporated with the field of gravitation to form the field of gravity.

centrifuge. Specifically, a large motor-driven apparatus with a long arm at the end of which human and animal subjects or equipment can be revolved and rotated at various speeds to simulate (very closely) the (prolonged) accelerations encountered in high-performance aircraft, rockets, and spacecraft. Sometimes called *astronautic centrifuge.*

centripetal acceleration. The **acceleration** on a particle moving in a curved path, directed toward the instantaneous center of curvature of the path, with magnitude v^2/R, where v is the speed of the particle and R the radius of curvature of the path. This acceleration is equal and opposite to the **centrifugal force** per unit mass.

CEP (*abbr*) = **circle of equal probability.**

Cep, Ceph. International Astronomical Union abbreviations for *Cepheus.* See **constellation.**

Cepheus (*abbr* **Cep, Ceph**). See **constellation.**

ceramal = **cermet.**

ceramic. An inorganic compound or mixture requiring heat treatment to fuse it into a homogeneous mass usually possessing high temperature strength but low ductility.

Types and uses range from china for dishes to **refractory** liner for **nozzles.**

Cerenkov radiation. The **radiation** from a charged **particle** whose velocity is greater than the **phase velocity** that an electromagnetic wave would have if it were propagating in the medium. The particle will continue to lose energy by radiation until its velocity is less than this phase velocity.

This phenomenon is analagous to the generation of a shock wave when an object is traveling faster than the sound velocity of the medium. A bow wave is set up which radiates energy into the medium and slows down the object.

The angle that the cone of **luminescence** makes with the direction of motion of the particle can be used to measure the velocity of the particle.

cermet [*cer*amic + *met*al]. A body consisting of ceramic particles bonded with a metal; used in aircraft, rockets, and spacecraft for high strength, high temperature applications. Also called *ceramal* [*ceram*ic + *al*loy].

Cet, Ceti. International Astronomical Union abbreviations for *Cetus.* See **constellation.**

cetane number. A number indicating the relative ignitability of a fuel oil for compression-ignition engines.

Ceti. International Astronomical Union abbreviation for *Cetus.* See **constellation.**

Cetus (*abbr* **Cet, Ceti**). See **constellation.**

C-figure = C-index.

CGS system. A system of units based on the centimeter, the gram, and the second.

Cha, Cham. International Astronomical Union abbreviations for *Chamaeleon.* See **constellation.**

chad. The piece removed when punching a hole, as in a card. See **chadless.**

chadless. A type of punching in which the chad is left attached by about 25 percent of the circumference of the hole, at the leading edge.

Chadless punching is used where it is undesirable to mutilate information written or printed on the punched medium.

chaff = window.

chain radar beacon. A **radar beacon** with a very fast recovery time.

This recovery time provides the possibility of simultaneously interrogating and tracking the beacon by as many radars as required so long as they are phased, synchronized, or the sum total pulse recurrence frequency does not exceed the maximum pulse recurrence frequency characteristics of the beacon.

chain reaction. A reaction in which one of the agents necessary to the reaction is itself produced by the reaction, thus causing like reactions.

In the neutron-fission chain reaction, a neutron striking a fissionable atom causes a fission releasing neutrons which cause other fissions.

challenger = interrogator-responsor.

Cham. International Astronomical Union abbreviation for *Chamaeleon.* See **constellation.**

Chamaeleon (*abbr* **Cha, Cham**). See **constellation.**

chamber = combustion chamber.

chamber pressure (*symbol* P_c). The pressure of gases within the **combustion chamber** of a **rocket** engine.

chamber volume (*symbol* V_c). The volume of the rocket **combustion chamber** including the convergent portion of the **nozzle** up to the throat.

change of the moon = new moon.

channel. 1. Short for *frequency channel.* **2.** In computer operations: (a) That portion of a **storage** medium which is accessible to a given reading station. See **track.** (b) A path of flow, usually including one or more operations.

Chapman region. A hypothetical region in the **upper atmosphere** in which the distribution of electron density with height can be described by a theoretical equation derived by Sydney Chapman.

Some of the basic assumptions used to develop the equation were that the ionizing radiation from the sun is essentially monochromatic, that the ionized constituent is distributed exponentially (with a constant **scale height**), and that there is an equilibrium condition between the creation of free electrons and their loss by recombination.

Chappius bands. See **absorption band.**

character. One of a set of elementary marks or events which may be combined to express information.

For example, a decimal digit (0 to 9), a letter (A to Z), or a symbol (comma, plus, minus, etc.).

characteristic. Specifically, a distinguishing quality, property, feature, or **capability** of a machine or piece of equipment, or of a component part.

The characteristics of an aircraft are (1) qualities such as stability, maneuverability, and strength; (2) features such as number, kind, or power of engines, and size, shape, or number of wings; and (3) capabilities such as range, speed, and payload.

characteristic chamber length (*symbol* L^*). The length of a straight cylindrical tube having the same volume as the chamber of a **rocket engine** would have if it had no converging section.

characteristic equation. 1. An equation defining the characteristics of a set of partial differential equations. **2.** A linear algebraic equation determining the **eigenvalues** or free waves of a boundary-value problem. See **characteristic-value problem.**

characteristic exhaust velocity (*symbol* c^*). Of a **rocket engine,** a descriptive parameter,

$$c^* = V_e/C_F$$

where V_e is effective exhaust velocity and C_F is thrust coefficient. Also called *characteristic velocity*.

characteristic Larmor radius. The size of the **Larmor orbit** of a charged particle whose rotational velocity is equal to the **Alfvén speed.**

characteristic length (*symbol* l, ℓ). A convenient reference length (usually constant) of a given configuration, such as overall length of an aircraft, the maximum diameter or radius of a body of revolution, a chord or span of a lifting surface, etc.

characteristic mode = normal mode of vibration.

characteristics. Lines or surfaces associated with a partial differential equation, or with a set of such equations, which are at all points tangent to characteristic directions, determined by certain specified linear combinations of the equations.

The use of these lines or surfaces may facilitate the solution of the equations and is known as the *method of characteristics*. The method has been particularly successful, for example, in the problem of finite-amplitude expansion and shock waves.

characteristic value. See **characteristic-value problem.**

characteristic-value problem. A problem in which an undetermined **parameter** is involved in the coefficients of a differential equation, and in which the solution of the differential equation, with associated boundary conditions, exists only for certain discrete values of the parameter, called *eigenvalues*, or *characteristic values*, sometimes *principal values*.

An important example of a physical problem which leads to a characteristic-value problem is the determination of the modes and frequencies of a vibrating system. In this case the dependent variable of the differential equation represents the displacements of the system and the parameter represents the frequencies of vibration.

characteristic velocity (*symbol* **c***) **= characteristic exhaust velocity.**

charge neutrality. The approximate equality of positive and negative particles in high-density **plasmas.**

This phenomenon, which is sometimes called *electrical neutrality*, is a result of the extremely large electric space charge fields that would arise if the densities were not equal. Although the positive and negative charge densities are seldom exactly equal, their percentage difference is so small as to be negligible. It is not difficult to maintain this condition in an active plasma since **ionization** or **recombination** always produces or destroys an ion pair together.

charge spectrum. The range and magnitude of electric charges with reference to **cosmic rays** at a specific altitude.

Charles-Gay-Lussac law. An empirical generalization that in a gaseous system at constant pressure, the temperature increase and the relative volume increase stand in approximately the same proportion for all so-called perfect gases. Mathematically,

$$t - t_0 = (1/c\ [(v - v_0)/v_0]$$

where t is temperature; v is volume; and c is a coefficient of thermal expansion independent of the particular gas. If the centigrade temperature scale is used and v_0 is the volume at 0° C, then the value of the constant c is approximately 1/273. Also called *Charles law*, *Gay-Lussac law*.

Charles law = Charles-Gay-Lussac law.

charring ablator. An **ablation material** characterized by the formation of a carbonaceous layer at the heated surface which impedes heat flow into the material by its insulating and reradiating characteristics.

chase pilot. A pilot who flies an escort airplane advising a pilot who is making a check, training, or research flight in another craft.

chaser. The vehicle that maneuvers in order to effect a **rendezvous** with an orbiting object.

check flight. **1.** A flight made to check or test the performance of an aircraft, rocket, or spacecraft, or a piece of equipment or component, or to obtain measurements or other data on performance; a **test flight.** **2.** A familiarization flight in an aircraft, or a flight in which a pilot or other aircrew member or members are tested or examined for proficiency.

checking. Presence of a network of fine hairline cracks on the surface of a structure usually induced by poor machining technique.

checkout. **1.** A sequence of actions taken to test or examine a thing as to its readiness for incorporation into a new phase of use, or for the performance of its intended function. **2.** The sequence of steps taken to familiarize a person with the operation of an airplane or other piece of equipment.

In sense 1, a checkout is usually taken at a transition point between one phase of action and another. To shorten the time of checkout, automation is frequently employed.

checkout GSE. **Ground support equipment** used to make a **checkout,** which see, sense **1.**

cheese antenna. A cylindrical **parabolic reflector** enclosed by two plates perpendicular to the cylinder, so spaced as to permit the propagation of more than one mode in the desired direction of polarization.

chemical energy. **Energy** produced or absorbed in the process of a chemical reaction.

In such a reaction, energy losses or gains usually involve only the outermost **electrons** of the atoms or ions of the system undergoing change; here a chemical bond of some type is established or broken without disrupting the original atomic or ionic identities of the constituents.

Chemical changes, according to the nature of the materials entering into the change, may be induced by heat (*thermochemical*), light (*photochemical*), and electric (*electrochemical*) energies.

chemical fuel. **1.** A **fuel** that depends upon an **oxidizer** for combustion or for development of thrust, such as liquid or solid rocket fuel or internal-combustion-engine fuel; distinguished from **nuclear fuel.** **2.** A fuel that uses special chemicals, such as the fuel once projected for the afterburner of the B–70.

chemical pressurization. The **pressurization** of propellant tanks in a **rocket** by means of high-pressure gases developed by the combustion of a fuel and oxidizer or by the decomposition of a substance.

chemiluminescence. Any **luminescence** produced by chemical action. See **airglow.**

chemisorption. The binding of a liquid or gas on the surface or in the interior of a solid by chemical bonds or forces.

chemosphere. The vaguely defined region of the upper atmosphere in which **photochemical reactions** take place. It is generally considered to include the stratosphere (or the top thereof) and the mesosphere, and sometimes the lower part of the thermosphere. See **atmospheric shell.**

This entire region is the seat of a number of important photochemical reactions involving atomic oxygen O, molecular oxygen O_2, ozone O_3, hydroxyl OH, nitrogen N_2, sodium Na, and other constituents to a lesser degree.

chest-to-back acceleration. See **physiological acceleration.**

chirp. An all-encompassing term for the various techniques of pulse expansion-pulse compression applied to **pulse radar;** a technique to expand narrow pulses to wide pulses for transmission, and compress wide received pulses to the original narrow pulse width and wave shape, to gain improvement in **signal-to-noise ratio** without degradation to range resolution and range discrimination.

chi-square test. A statistical significance test based on frequency of occurrence; it is applicable both to qualitative attributes and quantitative variables. Among its many uses, the most common are tests of hypothesized probabilities or probability distributions (goodness of fit), statistical dependence or independence (association), and common population (homogeneity).

The formula for chi square (χ^2) depends upon intended use, but is often expressible as a sum of terms of the type $(f - h)^2/h$ where f is an observed frequency and h is its hypothetical value.

chlorate candle. A mixture of solid chemical compounds which, when ignited, liberates free oxygen.

Chlorella. A genus of unicellular green **algae,** considered to be adapted to converting carbon dioxide into oxygen in a closed ecological system. See **closed ecological system.**

choked flow. **Flow** in a duct or passage such that the flow upstream of a certain critical section cannot be increased by a reduction of downstream pressure.

chokes. Pain and irritation in the chest and throat as a result of reduced ambient pressure.

choking Mach number. The **Mach number** at some reference point in a duct or passage (e.g., at the inlet) at which the flow in the passage becomes choked. See **choked flow.**

chondrite. A meteoritic stone characterized by small rounded grains or spherules.

chopper. A device used to interrupt the path of radiation, as a beam of light, from a single source or to alternate it between two sources.

chord. **1.** A straight line intersecting a circle or other curve, or a straight line connecting the ends of an arc. **2.** (*symbol* **c**). In aeronautics, a straight line intersecting or touching an airfoil profile at two points; specifically, that part of such a line between two points of intersection.

This line is usually a **datum line** joining the leading and trailing edges of an airfoil, joining the ends of the mean line of an airfoil profile, or running along the lower surface or line of an airfoil profile, from which the ordinates and angles of the airfoil are measured. As such a datum line, it is sometimes called the *geometric chord,* to distinguish it from a chord established on the basis of any other considerations.

3. = **chord length.**

In sense **3,** points or stations along a chord are designated in percentages or fractions of the chord or chord length from the leading edge, as, a point at 25 percent, or one-quarter, chord.

chord length. The length of the **chord** of an **airfoil** section between the extremities of the section.

For many airfoils, the chord is established intersecting the airfoil profile at its extremities, and the chord length is equal to the length of the chord between the points of intersection; for airfoils where the chord is established by a point or points of tangency or intersection not at the extremities, however, the chord length is considered to extend beyond either or both points, as necessary, to equal the maximum length of the profile. See **chord,** senses **2** and **3.**

choroisotherm. See **isotherm,** note.

chromatography. The separation of chemical substances by making use of differences in the rates at which the substances travel through or along a stationary medium.

chromosphere. A thin layer of relatively transparent gases above the photosphere of the sun.

chronoisotherm. See **isotherm,** note.

chronometer noon. See **solar noon.**

chronometer time. See **time.**

chronometric data. Data in which the desired quantity is the time of occurrence of an event or the time interval between two events.

chronotron. A device which utilizes a measurement of the position of the superposed loci of a pair of **pulses** on a transmission line to determine the time between the events which initiate the pulses.

chuffing = chugging.

chugging. A form of **combustion instability** in a **rocket engine,** characterized by a pulsing operation at a fairly low frequency, sometimes defined as occurring between particular frequency limits; the noise made in this kind of combustion. Also called *chuffing*, *bumping*.

C-index. A subjectively obtained daily index of geomagnetic activity. Each day's record is evaluated on the basis of 0 for quiet, 1 for moderately disturbed, and 2 for very disturbed. Also called *C-figure*, *magnetic character figure*. See **geomagnetism.**

cine-theodolite. A photographic **tracking** instrument which records on each film frame the target and the azimuth and elevation angles of the optical axis of the instrument. Also called *Askania*.

Cir, Circ. International Astronomical Union abbreviations for *Circinus*. See **constellation.**

circadian rhythm. A regular change in physiological function occurring in approximately 24-hour cycles.

Circinus (*abbr* **Cir, Circ**). See **constellation.**

circle of declination = hour circle.

circle of equal altitude = parallel of altitude.

circle of equal declination = parallel of declination.

circle of equal probability (*abbr* **CEP**). A measure of the accuracy with which a rocket or missile can be guided; the radius of the circle at a specific distance in which 50 percent of the reliable shots land. Also called *circular error probable*, *circle of probable error*.

circle of latitude. A **great circle** of the **celestial sphere** through the **ecliptic poles,** and hence perpendicular to the plane of the **ecliptic.**

circle of longitude. A circle of the **celestial sphere,** parallel to the **ecliptic.** Also called *parallel of latitude*.

circle of probable error = circle of equal probability.

circle of right ascension = hour circle.

circuit. A **network** providing one or more closed paths.

circuit element. See **element,** sense **2.**

circular area. Of a circle, the square of the diameter.

Circular area = 1.2733 × true area.
True area = 0.785398 × circular area.

circular cylindrical coordinates = cylindrical coordinates.

circular dispersion (*abbr* **CD**). In rocketry, the diameter of a circle within which 75 percent of the events under study occur. CD = 3.330 σ where σ = standard deviation.

Circular dispersion is most often used as a measure of error of the accuracy with which rockets reach their intended target.

circular error probable = circle of equal probability.

circular frequency = angular frequency (*symbol* ω).

circular inch. The area of a circle 1 inch in diameter.

circularly polarized sound wave. A **transverse wave** in an elastic medium in which the displacement vector at any point rotates about the point with constant angular velocity and has a constant magnitude.

A circularly polarized wave is equivalent to two superposed plane polarized waves of sinusoidal form in which the displacements have the same amplitude, lie in perpendicular planes, and are in quadrature.

circularly polarized wave. An **electromagnetic wave** for which the electric or the magnetic field vector, or both, at a point describe a circle.

This term is usually applied to **transverse waves.**

circular mil. The area of a circle with a diameter of 0.001 inch; a unit used for the measurement of small circular areas, such as the cross section of a wire.

One circular mil = 7.85×10^{-7} square inch.

circular polarization. The polarization of a **wave** radiated by a constant electric vector rotating in a plane so as to describe a circle. See **elliptical polarization.**

circular scanning. Scanning in which the direction of maximum radiation generates a plane or a right circular cone whose vertex angle is close to 180°.

circular velocity. At any specific distance from

the primary, the orbital velocity required to maintain a constant-radius **orbit.**

circulating memory = delay-line storage.

circulating register = delay-line storage.

circulation. **1.** The flow or motion of a fluid in or through a given area or volume. **2.** A precise measure of the average flow of fluid along a given closed curve. Mathematically, circulation is the line integral.

$$\oint \mathrm{v} \cdot \mathrm{dr}$$

about the closed curve, where v is the fluid velocity, and dr is a vector element of the curve.

By *Stokes theorem*, the circulation about a plane curve is equal to the total vorticity of the fluid enclosed by the curve.

The given curve may be fixed in space or may be defined by moving fluid parcels.

circulation integral. The line integral of an arbitrary vector taken around a closed curve. Thus,

$$\oint \mathrm{a} \cdot \mathrm{dr}$$

is the circulation integral of the vector a around the closed curve; dr is an infinitesimal vector element of the curve. If the vector is the velocity, this integral is called the *circulation.*

circumlunar. Around the moon, generally applied to **trajectories.**

cislunar. [Latin cis, *on this side*]. Of or pertaining to phenomena, projects, or activity in the space between the earth and moon, or between the earth and the moon's orbit. Compare **translunar, circumlunar.**

civil day. See **mean solar day.**

civil time. See **mean time,** note.

civil twilight. See **twilight,** note.

civil year = calendar year.

clad = cladding.

cladding. A coating placed on the surface of a material and usually bonded to the material. Also called *clad.*

Cladding is used extensively in nuclear reactor cores to prevent corrosion of the fissionable material by the coolant.

clamping circuit. **1.** A **circuit** which maintains either extremity of a **waveform** at a prescribed potential. **2.** A **network** for adjusting the absolute voltage level of a waveform.

Clapeyron-Clausius equation. The differential equation relating pressure to temperature in a system in which two phases of a substance are in equilibrium.

$$dp/dT = L/(T\Delta V)$$

where p is pressure; T is temperature; L is the latent heat of the phase change; and ΔV is the difference in volume of the phases. Also called *Clapeyron equation, Clausius-Clapeyron equation.*

Clapeyron equation = Clapeyron-Clausius equation.

Clausius-Clapeyron equation = Clapeyron-Clausius equation.

cleanup. **1.** The process of removing gas from a vacuum system or device by **sorption** or ion pumping. **2.** In aeronautics, the process of improving external shape and smoothness of an aircraft to reduce its **drag.**

clear. To restore a **storage** or **memory** device to a prescribed state, usually that denoting zero. See **reset.**

climatology. See **meteorology,** note.

clipper = clipping circuit.

clipping circuit. A pulse-shaping **network** which removes that part of a **waveform** which tends to extend above, or below, a chosen voltage level. Also called *clipper.*

clo. The amount of insulation which will maintain normal skin temperature of the human body when heat production is 50 kilogram-calorie per meter squared per hour, air temperature is 70° F, and the air is still.

One clo is roughly equivalent to the amount of insulation provided by the average businessman's suit in a temperate climate.

clock frequency. The master **frequency** of periodic **pulses** which schedule the operation of a machine, as a computer.

clock pulse. A **pulse** used for timing purposes.

In pulse-code-modulation systems, a timing pulse which occurs at the **bit rate.**

closed ecological system. A system that provides for the maintenance of life in an isolated living chamber through complete reutilization of the material available, in particular, by means of a cycle wherein exhaled carbon dioxide, urine, and other waste matter are converted chemically or by photosynthesis into oxygen, water, and food. Compare **controlled-leakage system, open system.**

closed-loop system. A system in which the **output** is used to control the **input.** See **feedback control loop.**

closed-loop telemetry **1.** A **telemetry** system which is used as the indicating portion of a remote-control system. **2.** A system used to check out test vehicle or telemetry performance without radiation of radio-frequency energy.

closed respiratory gas system. A completely self-contained system within a sealed cabin, capsule, or spacecraft that will provide adequate oxygen for breathing, maintain adequate cabin pressure, and absorb the exhaled carbon dioxide and water vapor.

closed system. **1.** In thermodynamics, a system so chosen that no transfer of mass takes place across its boundaries; for example, a fluid parcel undergoing a saturation-adiabatic process, as opposed to a pseudoadiabatic expansion. See **open system.** **2.** In mathematics, a system of differential equations and supplementary conditions such that the values of all the unknowns (dependent variables) of the system are mathematically determined for all values of the independent variables (usually space and time) to which the system applies. **3.** = **closed ecological system.** **4.** A system which constitutes a **feedback** loop so that the inputs and controls depend on the resulting output. For example, an automatic radar-controlled tracking system.

closest approach. **1.** The event that occurs when two planets or other **celestial bodies** are nearest to each other as they orbit about the sun or other **primary.** **2.** The place or time of such an event.

closing rate. The speed at which two bodies approach each other.

cloud absorption. The **absorption** of **electromagnetic radiation** by the water drops and water vapor within a cloud. Compare **cloud attenuation.**

For **insolation** (incoming solar radiation), clouds absorb rather small fractions, particularly of the shorter wavelengths. Even for depths of clouds of the order of 20,000 feet, measurements suggest absorptions of less than 30 percent, while layers only 1000 or 2000 feet thick may absorb only about 5 percent. However, for long-wave **terrestrial radiation,** even very thin layers of cloud act as almost complete black-body absorbers.

cloud attenuation. Usually, the reduction in intensity of **microwave radiation** by clouds in the earth's atmosphere. For the centimeter wavelength band, clouds produce **Rayleigh scattering.** The attenuation is due largely to scattering, rather than to absorption, for both ice and water clouds. See **precipitation attenuation.** Compare **cloud absorption.**

cloud band. A broad band of clouds, from about 10 to 100 or more miles wide, and varying in length from a few tens of miles to hundreds of miles. See **cloud streets**

cloud chamber. A device for observing the paths of **ionizing particles,** based on the principle that supersaturated vapor condenses more readily on ions than on neutral molecules.

cloud physics. A subdivision of **physical meteorology** concerned with physical properties of clouds in the atmosphere and the processes occurring therein.

Cloud physics, broadly considered, embraces not only the study of condensation and precipitation processes in clouds, but also radiative transfer, optical phenomena, electrical phenomena, and a wide variety of hydrodynamic and thermodynamic processes peculiar to natural clouds.

cloud seeding. Any technique carried out with the intent of adding to a natural cloud in a planetary atmosphere certain substances that will alter the natural development of that cloud.

cloud street. A line of cumuliform clouds frequently one cumulus element wide, but ranging upward in width so that it is sometimes difficult to differentiate between streets and bands. Typical dimensions are: axis spacing, 1 to 30 miles; length of cloud streets, 10 to 200 miles; cell spacing along axis, $\frac{1}{2}$ to 2 miles. See **cloud band.**

clusec. A **flow rate** equal to 0.01 **lusec.**

cluster. Two or more **rocket motors** bound together so as to function as one propulsion unit.

clutter. **1.** **Atmospheric noise,** extraneous signals, etc., which tend to obscure the reception of a desired signal in a radio receiver, radarscope, etc.

As compared with *interference, clutter* refers more particularly to unwanted reflections on a radar **plan position indicator,** such as ground return, but the terms are often used interchangeably.

2. = **window.**

CMa, C Maj. International Astronomical Union abbreviations for *Canis Major.* See **constellation.**

CMi, C Min. International Astronomical Union abbreviation for *Canis Minor.* See **constellation.**

Cnc, Canc. International Astronomical Union abbreviations for *Cancer.* See **constellation.**

co. **1.** A prefix meaning 90° minus the value with which it is used. Thus, if the *latitude* is 30°, the *colatitude* is $90° - 30° = 60°$. **2.** A prefix meaning in common, as in *coaxial,* having a common axis.

coaltitude = **zenith distance.**

coast. A memory feature on a **radar** which, when activated, causes the range and angle systems to continue to move in the same direction and at the same speed as that required to track an original target.

Coast is used to prevent **lock-on** to a stronger target if approached by the target being tracked.

coasting flight. The flight of a **rocket** between **burnout** or thrust cutoff of one stage and ignition of another, or between burnout and summit altitude or maximum horizontal range.

coated optics. Optical elements (lenses, prisms, etc.) which have their surfaces covered with a

thin transparent film to minimize reflection and loss of light in the system.

coaxial cable. A form of **waveguide** consisting of two concentric conductors insulated from each other.

codan (*abbr*) = **carrier operated device, antinoise.** A device which silences a receiver except when a carrier signal is being received.

code. **1.** A system of symbols or **signals** for representing **information**, and the rules for associating them. **2.** The set of characters resulting from the use of a code as defined in sense **1.** **3.** Specifically, to translate a problem to a **routine** expressed in machine language for a specific **computer.** **4.** To express given information by means of a code, to encode.

codeclination. Ninety degree minus the **declination.** When the declination and latitude are of the same name, codeclination is **polar distance** measured from the **elevated pole.**

coded decimal digit. In computer operation, a **decimal digit** expressed in a code, usually a four-digit **binary code.**

coding. The arrangement in a coded form, usually acceptable to a specific **computer,** of the instructions for the operations necessary to solve a problem.

coefficient (*abbr* **coeff**). **1.** A number indicating the amount of some change under certain specified conditions, often expressed as a ratio.

For example, the coefficient of linear expansion of a substance is the ratio of its change in length to the original length for a unit change of temperature from a standard.

2. A constant in an algebraic equation. **3.** One of several parts which combine to make a whole, as the maximum deviation produced by each of several causes.

coefficient of barotropy. See **barotropy.**

coefficient of compressibility. The relative decrease of the volume of a gaseous system with increasing pressure in an **isothermal** process. This coefficient is

$$-(1/V)(\partial V/\partial p)_T$$

where V is the volume; p is the pressure; and T is the temperature. The reciprocal of this quantity is the **bulk modulus.** Also called *compressibility*. Compare **coefficient of thermal expansion, coefficient of tension.**

coefficient of diffusion = **diffusivity.**

coefficient of heat conduction = **thermal conductivity.**

coefficient of molecular viscosity = **dynamic viscosity.**

coefficient of mutual diffusion. A quantity in the kinetic theory of gases which measures the tendency of gases to diffuse into one another in nonturbulent flow.

This diffusion coefficient is a property of the gases in question and of the assumed nature of the molecular impacts in the **diffusion** process. For rigid, perfectly elastic, spherical molecules the coefficient of mutual diffusion $d_{1,2}$ is, in square centimeters per second,

$$d_{1,2} = \frac{3}{4n(\sigma_1 + \sigma_2)^2}\left[\frac{2kT(m_1 + m_2)}{m_1 m_2}\right]^{1/2}$$

where n is Loschmidt number (the number of molecules per cubic centimeter); σ_1, σ_2, and m_1, m_2 are the effective molecular diameters and masses of the two gases, respectively; T is the temperature, °K; and k is Boltzmann constant.

coefficient of polytropy. See **polytropic process.**

coefficient of tension. The relative increase of pressure of a system with increasing temperature in an **isochoric** process. In symbols this quantity is

$$(1/p)(\partial p/\partial T)_V$$

where p is pressure; T is temperature; and V is volume. Compare **coefficient of compressibility, coefficient of thermal expansion.**

coefficient of thermal conduction = **thermal conductivity.**

coefficient of thermal conductivity = **thermal conductivity.**

coefficient of thermal expansion. The ratio of the change of length per unit length (*linear*), or change of volume per unit volume (*voluminal*), to the change of temperature.

coefficient of viscosity = **dynamic viscosity.**

coherence. In radar, a relation between two **wave trains** such that, when they are brought into coincidence, they are capable of producing interpretable interference phenomena.

This is limited to those wave trains which have fixed or slowly varying phase relationships with each other.

In contrast are the rapid interference phenomena produced by the superposition of the more or less randomly scattered waves from hydrometeors.

coherent. **1.** Of electromagnetic radiation, being **in phase,** so that waves at various points in space act in unison, as in a *laser producing coherent light.* **2.** Having a fixed relation between frequency and phase of input and output signal.

coherent carrier. A **carrier wave** derived from a continuous-wave signal in such a way that its **frequency** and **phase** have a fixed relationship to the frequency and phase of the reference signal.

coherent echo. A radar **echo** whose **phase** and **amplitude** at a given range remain relatively constant.

Hills, buildings, and slowly moving point targets such as ships are examples of objects which produce coherent radar echoes. Volume targets (such as clouds and pre-

cipitation) give noncoherent echoes. The classification of an echo as coherent or noncoherent is closely related to the spatial resolution (beam width) of the radar or the volume occupied by the radar pulse. Thus, small atmospheric inhomogeneities which give rise to noncoherent echoes, would give coherent echoes if the radar volume were reduced in size to the order of magnitude of the inhomogeneities themselves.

coherent oscillator (*abbr* **Coho**). An **oscillator** which provides a reference by which the radio-frequency **phase** difference of successive received pulses may be recognized. See **coherent reference.**

coherent radar. A type of **radar** that employs circuitry which permits comparison of the **phase** of successive received target signals.

coherent reference. The reference **signal,** usually of stable frequency, to which other signals are **phase-locked** to establish **coherence** throughout a system.

coherent transponder. A **transponder,** the output signal of which is **coherent** with the input signal.

Coho (*abbr*) = **coherent oscillator.**

coincidence circuit. An electronic **circuit** that produces a usable **output** pulse only when each of two or more **input** circuits receive pulses simultaneously or within an assignable time interval.

coincidence counter. A device using **ionization counters** and **coincidence circuits** to count and determine the direction of travel of **ionizing particles,** particularly cosmic rays.

coincident-current magnetic core. A **binary magnetic core** in which information is stored as the result of current flowing simultaneously in two or more independent windings.

Usually a number of cores are arranged in the form of a matrix.

Col, Colm. International Astronomical Union abbreviations for *Columba.* See **constellation.**

colatitude. Ninety degrees minus the **latitude.**

cold cathode. A **cathode** whose operation does not depend on its temperature being above the ambient temperature.

cold-cathode gage = **cold-cathode ionization gage.**

cold-cathode ionization gage. An **ionization gage** (vacuum gage) in which the ions are produced by a discharge between two electrodes, both near room temperature. The discharge usually takes place in the presence of a magnetic field which lengthens the path of the electrons between cathode and anode.

One form of gage is a transparent tube in which the color and form of a cold-cathode discharge, without the presence of a magnetic field, give an indication of the pressure and the nature of the gas. The Philips ionization gage, or Penning gage, is a cold-cathode ionization gage in which a magnetic field is used. Various modifications of the Penning gage are named after the inventors, and certain types are referred to as magnetron vacuum gages.

cold-flow test. A test of a **liquid rocket** without firing it to check or verify the efficiency of a propulsion subsystem, providing for the conditioning and flow of **propellants** (including tank pressurization, propellant loading, and propellant feeding).

cold-pressor test. A test for measuring the response of heart and blood pressure to the stress of plunging an extremity (foot or hand) into ice water.

The normal response is an increase in both heart rate and blood pressure.

cold working. Deforming metal plastically at a temperature lower than the recrystallization temperature.

coleopter. An **aircraft** having an annular (barrel-shaped) wing, the engine and body being mounted within the circle of the wing.

collimate. 1. To render parallel, as rays of light. **2.** To adjust the line of sight of an optical instrument, such as a theodolite, in proper relation to other parts of the instrument.

collimation error. The angular error in magnitude and direction between two nominally parallel lines of sight; specifically, the angle by which the **line of sight** of an optical instrument or radar differs from what it should be.

collimation tower. A tower on which are mounted a visual and a radio target for use in checking the electrical **axis** of an **antenna.**

collimator. An optical device which renders rays of light parallel.

collision. An encounter between two **particles** that changes their existing **momentum** and energy conditions. See **elastic collision.**

The products of the collision may or may not be the same as the precollision particles. The collision may be actual contact or the close approach and deflection of the particles.

collision broadening. In spectroscopy, the broadening or spreading of an **emission line,** due to the interruption of the radiating process by a **collision** of the radiator with another **particle.**

In the case of **cyclotron radiation,** the collision will actually change the phase of the radiation. For many collisions, this has the effect of broadening the observed frequencies by an amount equal to the collision **rate.**

collision cross section. See **cross section.** See also **elastic collision, coulomb collision.**

collision frequency = **collision rate.**

collision frequency per molecule = **collision rate.**

collision frequency per unit volume. The

number of collisions between molecules in a gas per unit volume per unit time.

collision parameter. **1.** In orbit computation, the distance between a center of attraction of a **central force field** and the extension of the velocity vector of a moving object at a great distance from the center. **2.** In gas dynamics and atomic physics, any of several parameters, such as **cross section, collision rate, mean free path,** etc., which provide a measure of the probability of collision.

collision rate. The average number of **collisions** per second suffered by a molecule or other **particle** moving through a gas. Also called *collision frequency*.

colloid. See **colloidal system.**

colloidal dispersion = colloidal system.

colloidal suspension = colloidal system.

colloidal system. An intimate mixture of two substances one of which, called the *dispersed phase* (or *colloid*) is uniformly distributed in a finely divided state through the second substance, called the *dispersion medium* (or *dispersing medium*). The dispersion medium may be a gas, a liquid, or a solid, and the dispersed phase may also be any of these, with the exception that one does not speak of a colloidal system of one gas in another. Also called *colloidal dispersion, colloidal suspension.*

A system of liquid or solid particles colloidally dispersed in a gas is called an *aerosol*. A system of solid substance or water-insoluble liquid colloidally dispersed in liquid water is called a *hydrosol*. There is no sharp line of demarcation between true solutions and colloidal systems on the one hand, or between mere suspensions and colloidal systems on the other. When the particles of the dispersed phase are smaller than about 1 millimicron in diameter, the system begins to assume the properties of a true solution; when the particles dispersed are much greater than 1 micron, separation of the dispersed phase from the dispersing medium becomes so rapid that the system is best regarded as a suspension.

Colm. International Astronomical Union abbreviation for *Columba*. See **constellation.**

colorblind. Applied to a photographic emulsion sensitive only to blue, violet, and ultraviolet light.

color equation. In astronomy, a measure of the color sensitivity of a method of observation, equal to the **color index** of a class K0 star.

color excess (*symbol* ***E***). The difference between the **apparent color index** of a star and its **true color index** as computed for its stellar type.

Color excess is a measure of **space reddening.**

color index (*symbol* ***C***). Of a star, the numerical difference between the apparent **photographic magnitude** m_{pg} and the apparent **photovisual magnitude** m_{pv} or

$$C = m_{pg} - m_{pv}$$

The color index is zero for class A0 stars of magnitudes between 5.5 and 6.5; it is positive for red stars and negative for bluish stars. Various other color indices can be formed by using apparent magnitudes measured in other systems. Thus, the intrinsic color index is apparent photographic magnitude minus apparent ultraviolet magnitude.

color sensitive. Referring to a photographic emulsion which is not **colorblind.**

An emulsion sensitive not only to blue, violet, and ultraviolet, but also to yellow and green, is called *orthochromatic;* if sensitive to red as well, it is called *panchromatic.*

color temperature. **1.** An estimate of the **temperature** of an incandescent body, determined by observing the **wavelength** at which it is emitting with peak intensity (its color) and using that wavelength in **Wien law.**

If such a body were an ideal black body, the temperature so estimated would be its true temperature and would also agree with its **effective temperature;** but for actual bodies, the color temperature is generally only an approximate value. Thus, the sun's color temperature is about 6100° K, a few hundred degrees hotter than most approximations of its effective temperature.

2. The temperature to which a **black body** radiator must be raised in order that the light it emits may match a given light source in color. [Usually expressed in degrees Kelvin (°K).]

Columba (*abbr* **Col, Colm**). See **constellation.**

column. In a structure, a body whose function is to carry **compression** loads to its longest dimension.

Com, Coma. International Astronomical Union abbreviations for *Coma Berenices*. See **constellation.**

Coma. International Astronomical Union abbreviation for *Coma Berenices.* See **constellation.**

coma. **1.** The gaseous envelope that surrounds the nucleus of a comet. **2.** In an optical system, a result of spherical aberration in which a point source of light, not on the axis, has a blurred, comet-shaped image.

Coma Berenices (*abbr* **Com, Coma**). See **constellation.**

combination coefficient. A measure of the specific rate of disappearance of **small ions** due to either (**a**) union with neutral **Aitken nuclei** to form new large ions, or (**b**) union with large ions of opposite sign to form neutral Aitken nuclei.

combined error. A term used to specify the largest possible error of an instrument in the presence of adding or interacting effects.

Generally applied to the largest error due to the combined effect of nonlinearity and hysteresis.

combustion chamber (*symbol c used as a subscript*). Any chamber for the combustion of fuel, specifically that part of the **rocket engine** in which the combustion of **propellants** takes place at high pressure. Also called *chamber*, *firing chamber.*

The combustion chamber plus the diverging section of the nozzle comprise the rocket thrust chamber.

combustion-chamber liner = **inner liner.**

combustion efficiency. The efficiency with which **fuel** is burned, expressed as the ratio of the actual energy released by the combustion to the potential **chemical energy** of the fuel.

combustion instability. Unsteadiness or abnormality in the **combustion** of fuel, as may occur, e.g., in a **rocket engine.**

combustion wave. A zone of burning propagated through a combustible medium.

combustor = **combustion chamber.**

comes (*plural*, **comites**). The smaller star in a **binary** system. Also called *companion.*

comet. A luminous member of the **solar system** composed of a head, or **coma,** and often with a spectacular gaseous trail extending a great distance from the head.

The orbits of comets are highly elliptical.

command. A **signal** which initiates or triggers an action in the device which receives the signal. In computer operations also called *instruction.*

command control. A system whereby functions are performed as the result of a transmitted **signal.**

command destruct. A **command control** system that destroys a flightborne test **rocket,** actuated on command of the range safety officer whenever the rocket performance indicates a safety hazard.

command guidance. The **guidance** of a spacecraft or rocket by means of electronic **signals** sent to receiving devices in the vehicle.

common item. An item of supply used in two or more **systems,** subsystems, or pieces of support equipment, including related **components** and spares.

communications satellite. A **satellite** designed to reflect or relay electromagnetic signals used for communication.

commutation. Sequential sampling, on a repetitive timesharing basis, of multiple data sources for transmitting or recording, or both, on a single channel.

commutation rate. Number of **commutator** inputs sampled per second.

commutator. A device used to accomplish **time division multiplexing** by repetitive sequential switching.

companion. The smaller body in a physical double-star system. See **binary star.** Also called *comes.*

companion body. A nose cone, last-stage rocket, or other body that orbits along with an earth **satellite.** Compare **afterbody.**

comparator. In computer operations, a device or circuit for comparing information from two sources.

compass. 1. An instrument for indicating a horizontal reference direction, specifically a magnetic compass. **2.** Referring to or measured from **compass north.**

compass meridian. See **meridian.**

compass north. The direction north as indicated by a **magnetic compass;** the reference direction for measurement of compass directions.

compatibility. 1. A characteristic ascribed to a major subsystem that indicates it functions well in the overall **system. 2.** Also applied to the overall system with reference to how well its various subsystems work together, as in *the vehicle has good compatibility.* **3.** Also applied to materials which can be used in conjunction with other materials and not react with each other under normal operating conditions.

compensation signals. In telemetry, a **signal** recorded on a tape, along with the data and in the same track as the data, used during the playback of data to correct electrically the effects of tape-speed errors.

compile. In computer terminology, to **assemble** the necessary subroutines into a main **routine** for a specific problem.

complement. 1. An angle equal to 90° minus a given angle.

Thus, 50° is the complement of 40°, and the two are said to be *complementary.* See **explement.**

2. The true complement of any quantity in positional notation, i.e., the quantity which, when added to the first quantity, gives the least quantity containing one more place. **3.** The base-minus-one complement of any quantity in positional notation; i.e., the quantity which, when added to the first quantity, gives the largest quantity containing the same number of places.

In many computing machines a negative quantity is represented as a complement of the corresponding positive quantity.

complementary angle = **complement.**

complementation. In **Boolean algebra,** an operation in which items are described by stating that they do not belong to a particular class or classes. See **NOT circuit.**

complementor. In computers, a device which performs a function corresponding to the operation of **complementation.**

complex. **1.** Short for **launch complex,** as in *Complex 25B at Cape Kennedy.* **2.** Pertaining to a magnitude composed of a real number and an imaginary number.

complexity units. In reliability studies of electronic devices, an approximate figure of merit for complexity based on the sum of the number of tubes plus the number of relays in a unit or system. The total number of parts is roughly 10 times the number of complexity units.

component. An article which is a self-contained element of a complete operating *unit* and performs a function necessary to the operation of that unit.

composite materials. Structural materials of metals, **ceramics,** or plastics with built-in strengthening agents which may be in the form of filaments, foils, powders, or flakes of a different compatible material.

composite propellant. A **solid rocket propellant** consisting of a fuel and an oxidizer neither of which would burn without the presence of the other.

compound centripetal acceleration = coriolis acceleration.

compressed air illness = caisson disease.

compressibility. **1.** The property of a substance, as air, by virtue of which its density increases with increase in pressure. **2.** = **coefficient of compressibility.**

In aerodynamics, this property of the air is manifested especially at high speeds (speeds approaching that of sound and higher speeds). Compressibility of the air about an aircraft may give rise to buffeting, aileron buzz, shifts in trim, and other phenomena not ordinarily encountered at low speeds, known generally as *compressibility effects.*

compressibility burble. A region of disturbed flow, produced by, and rearward of, a shock wave. See **burble.**

compressible flow. In aerodynamics, **flow** at speeds sufficiently high that density changes in the fluid cannot be neglected.

compression. **1.** = **ellipticity.** See **flattening.** **2.** More generally, the act of compressing, pressing together; as in *compression waves, compression ratio.*

compressional wave. In acoustics, a **wave** in an elastic medium which causes an element of the medium to change its volume without undergoing **rotation.** Mathematically, a compressional wave is one whose velocity field has zero curl. Also called *compression wave.*

A compressional plane wave is a **longitudinal wave**

compressor. A machine for compressing air or other fluid.

Compressors are distinguished (1) by the manner in which fluid is handled or compressed, as the **axial-flow, centrifugal, double-entry, free-vortex, mixed-flow, single-entry,** and **supersonic compressor;** or (2) by the number of stages, as the **multistage** or **single-stage compressor.** See individual entries on the different types.

compressor blade. Either a rotor blade or a stator blade in an axial-flow compressor; sometimes used restrictively (and ambiguously) for a compressor rotor blade. Compare **impeller vane.**

Compton effect. The decrease in **frequency** and increase in **wavelength** of **X-rays** or **gamma rays** when scattered by free electrons. Also called *Compton recoil effect.*

Compton electron. An orbital **electron** of an atom which has been ejected from its orbit as a result of an impact by a high-energy **quantum** of radiation (X-ray or gamma ray). Also called *Compton recoil electron.*

Compton recoil effect = Compton effect.

Compton recoil electron = Compton electron.

Compton wavelength (*symbol* λ_c). Of a particle, the distance h/mc, where h is the Planck constant, m is the mass of the particle, and c is the velocity of light.

The Compton wavelength of the electron (*symbol* λ_c) is 2.4261×10^{-10} centimeter; of the proton (*symbol* $\lambda_{c,p}$) is 1.32140×10^{-13} centimeter.

computer. **1.** A machine for carrying out calculations and performing specified transformations on information. Also called *computing machinery.* **2** One who computes, or who operates a computer.

computing efficiency. Of a computer, the percentage of the successful computation time during a defined period to the total time in that period. Also called *operating ratio.*

computing machinery. Machinery which can take in, give out, and store information, and also perform arithmetic and **logical operations** with the information. Usually called *computer*

condensation. **1.** The physical process by which a vapor becomes a liquid or solid; the opposite of **evaporation.** **2.** Specifically, in meteorology, the transformation from vapor to liquid. See **sublimation.**

condensation coefficient. The ratio of **condensation rate** to **impingement rate.**

condensation nucleus. **1.** A **particle,** either liquid or solid, upon which **condensation** of vapor beings. **2.** Specifically, in meteorology,

a particle upon which condensation of water begins in the atmosphere.

condensation rate. The number per square centimeter per second at which molecules condense on a surface.

condensation shock = **condensation shock wave.**

condensation shock wave. A sheet of discontinuity associated with a sudden **condensation** and fog formation in a field of **flow.** It occurs, e.g., on a wing, where a rapid drop in pressure causes the temperature to drop considerably below the dew point. Also called *condensation shock.*

condensation trail. A visible trail of condensed water vapor or ice particles left behind an aircraft, an airfoil, etc. in motion through the air. Also called a *contrail* or *vapor trail.*

There are three kinds of condensation trails: the aerodynamic type, caused by reduced pressure of the air in certain areas as it flows past the aircraft; the convection type, caused by the rising of air warmed by an engine; and the engine-exhaust, or exhaust-moisture, type, formed by the ejection of water vapor from an engine into a cold atmosphere.

conductance. **1.** In electricity, the ratio of the current flowing through an electric circuit to the difference of potential between the ends of the circuit, the reciprocal of **resistance.** See **conductivity.** **2.** In vacuum systems, the **throughput** Q under steady-state conservative conditions divided by the measured difference in pressure p between two specified cross sections inside a pumping system:

$$G = Q/(p_1 - p_2)$$

Conductance, on the other hand, varies with the dimensions of the conducting system, and is the reciprocal of the electrical resistance.

conductor. A substance or entity which transmits electricity, heat, sound, etc.

cone. **1.** A geometric configuration having a circular bottom and sides tapering off to an apex (as in nose cone). **2.** A type of light-sensitive cell in the retina. Cones are involved in color vision, high visual acuity, and **photopic vision.**

cone of escape. A hypothetical cone in the **exosphere,** directed vertically upward, through which an atom or molecule would theoretically be able to pass to outer space without a collision, that is, in which the **mean free path** is infinite. See **fringe region.**

Such a cone would open wider with increasing altitude above the **critical level of escape,** and would be nonexistent below the critical level of escape.

confidence factor. In statistics, the percentage figure that expresses **confidence level,** or proportion of times the statement should be correct that the estimated population parameter lies within the given **confidence interval.**

confidence interval. In statistics, a range of values which is believed to include, with a preassigned degree of confidence (**confidence level**), the true characteristic of the lot or universe a given percentage of the time.

For example: 95-percent confidence limits for a sample of 10 with a ratio of successes to total number tested of 0.9 (9 successes and 1 failure) would be 0.54 to 1.0. That is, even with an observed success ratio of 0.9 (90 percent) the best that can be said is that the true ratio lies between 0.54 (54 percent) and 1.0 (100 percent) an estimated 95 percent of the time.

confidence level. In statistics, the degree of desired trust or assurance in a given result.

A confidence level is always associated with some assertion and measures the **probability** that a given assertion is true. For example, it could be the probability that a particular characteristic will fall within specified limits, i.e., the chance that the true value of P lies between P = a and P = b. See **confidence interval.**

confidence limits. In statistics, the upper and lower extremes of the **confidence interval.**

configuration. **1.** Relative position or disposition of various things, or the figure or pattern so formed. **2.** A geometric figure, usually consisting principally of points and connecting lines. **3.** = **planetary configuration.** **4.** A particular type of a specific aircraft, rocket, etc., which differs from others of the same model by virtue of the arrangement of its components or by the addition or omission of auxiliary equipment as *long-range configuration, cargo configuration.*

Some writers use *constellation* as a synonym for *con-*

conduction. The transfer of energy within and through a conductor by means of internal particle or molecular activity and without any net external motion.

Conduction is to be distinguished from **convection** (of heat) and **radiation** (of all electromagnetic energy).

conduction band. A range of states in the **energy spectrum** of a solid in which **electrons** can move freely.

conductive equilibrium = **isothermal equilibrium.**

conductivity. **1.** The ability to transmit, as electricity, heat, sound, etc. **2.** A unit measure of electrical conduction; the facility with which a substance conducts electricity, as represented by the current density per unit electrical-potential gradient in the direction of flow.

Electrical conductivity is the reciprocal of electrical **resistivity** and is expressed in units such as mhos (reciprocal ohms) per centimeter. It is an intrinsic property of a given type of material under given physical conditions (dependent mostly upon temperature).

figuration in referring to the relative positions of spacecraft to each other, as in a rendezvous maneuver, or to celestial bodies. This usage should be discouraged.

confluence. The rate at which adjacent **flow** is converging along an axis oriented normal to the flow at the point in question. It is the opposite of **difluence.** Compare **convergence.**

conformal. Having correct angular representation.

conic. **1.** A curve formed by the intersection of a plane and a right circular cone. Originally called *conic section.*

The conic sections are the **ellipse,** the **parabola,** and the **hyperbola,** curves that are used to describe the paths of bodies moving in space.

The circle is a special case of the ellipse, an ellipse with an eccentricity of zero.

The conic is the locus of all points the ratio of whose distances from a fixed point, called the *focus,* and a fixed line, called the *directrix,* is constant.

2. In reference to satellite orbital parameters, without consideration of the perturbing effects of the actual shape or distribution of mass of the primary.

Thus, *conic perigee* is the perigee the satellite would have if all the mass of the primary were concentrated at its center.

conical beam. The **radar beam** produced by **conical scanning** methods.

This type of beam has an advantage over that produced by a single radiating element placed at the focus of a parabolic reflector in that much greater angular accuracy is possible in locating targets.

conical scanning. *Scanning* in which the direction of maximum radiation generates a cone whose vertex angle is of the order of the **beam width.** Such scanning may be either rotating or nutating, according as the direction of polarization rotates or remains unchanged.

conic section. The original name for **conic.**

conjunction. **1.** The situation of two **celestial bodies** having either the same **celestial longitude** or the same sidereal hour angle. Compare **opposition, quadrature.**

A planet is at superior conjunction if the sun is between it and the earth; at inferior conjunction if it is between the sun and the earth.

2. The time at which conjunction, as defined in sense **1,** takes place.

conservation of angular momentum. The principle that absolute **angular momentum** is a property which cannot be created or destroyed but can only be transferred from one physical **system** to another through the agency of a net torque on the system. As a consequence, the absolute angular momentum of an isolated physical system remains constant.

The principle of conservation of angular momentum can be derived from the Newton second law of motion.

conservation of energy. The principle that the total **energy** of an isolated system remains constant if no interconversion of **mass** and energy takes place.

This principle takes into account all forms of energy in the system; it therefore provides a constraint on the conversions from one form to another. See **energy equation, conservation of energy.**

conservation of mass. The principle in **Newtonian mechanics** which states that **mass** cannot be created or destroyed but only transferred from one volume to another. See **continuity equation.**

conservation of momentum. The principle that in the absence of forces absolute **momentum** is a property which cannot be created or destroyed. See **Newton laws of motion.**

console. An array of controls and indicators for the monitoring and control of a particular sequence of actions, as in the checkout of a rocket, a countdown action, or a launch procedure.

A console is usually designed around desklike arrays. It permits the operator to monitor and control different activating instruments, data recording instruments, or event sequencers.

constant-level balloon. A balloon designed to float at a constant-pressure level. Also called *constant-pressure balloon.* See **skyhook balloon.**

In one design for such a system, a pressure switch actuates a valve which controls the release of ballast so as to maintain flight above a selected pressure level until the supply of ballast is exhausted.

Another design is a simple nonextensible envelope capable of withstanding a differential of pressure, higher inside than out. It is inflated so that the smaller nighttime pressure of the gas still fully extends the envelope. Such a superpressure *balloon* will keep essentially constant level until enough gas diffuses out of it to allow diurnal changes in volume.

constant of aberration. The maximum **aberration** of a star observed from the surface of the earth, 20.49 seconds of arc.

The maximum occurs at the time the direction of motion of the earth in its orbit is at right angles to a line from the earth to the star.

constant of gravitation = Newtonian universal constant of gravitation.

constant of nutation. See **nutation,** note.

constant-pressure balloon = constant-level balloon.

constellation. Originally a conspicuous configuration of stars; now a region of the celestial sphere marked by arbitrary boundary lines.

The genitive form of constellation names is used in star names and numbers such as **Bayer name** and **Flamsteed number.** Table V lists the constellations.

TABLE V.—CONSTELLATIONS (in accordance with the resolutions of the International Astronomical Union)

Constellation	Genitive	Abbreviation		Right Ascension, h	Declination, deg
Andromeda	Andromedae	And	Andr	1	40 N
Antlia	Antliae	Ant	Antl	10	35 S
Apus	Apodis	Aps	Apus	16	75 S
Aquarius	Aquarii	Aqr	Aqar	23	15 S
Aquila	Aquilae	Aql	Aqil	20	5 N
Ara	Arae	Ara	Arae	17	55 S
Argo[a]	Argus	Arg			
Aries	Arietis	Ari	Arie	3	20 N
Auriga	Aurigae	Aur	Auri	6	40 N
Boötes	Boötis	Boo	Boot	15	30 N
Caelum	Caeli	Cae	Cael	5	40 S
Camelopardus	Camelopardalis	Cam	Caml	6	70 S
Cancer	Cancer	Cnc	Canc	9	20 N
Canes Venatici	Canum Venaticorum	CVn	C Ven	13	40 N
Canis Major	Can Majoris	CMa	C Maj	7	20 S
Canis Minor	Can Minoris	CMi	C Min	8	5 N
Capricornus	Capricorni	Cap	Capr	21	20 S
Carina	Carinae	Car	Cari	9	60 S
Cassiopeia	Cassiopeiae	Cas	Cass	1	60 N
Centaurus	Centauri	Cen	Cent	13	50 S
Cepheus	Cephei	Cep	Ceph	22	70 N
Cetus	Ceti	Cet	Ceti	2	10 S
Chamaeleon	Chamaelontis	Cha	Cham	11	80 S
Circinus	Circini	Cir	Circ	15	60 S
Columba	Columbae	Col	Colm	6	35 S
Coma Berenices	Comae Berenices	Com	Coma	13	20 N
Corona Austrina	Coronae Austrinae	CrA	Cor A	19	40 S
Corona Borealis	Coronae Borealis	CrB	Cor B	16	30 N
Corvus	Corvi	Crv	Corv	12	20 S
Crater	Crateris	Crt	Crat	11	15 S
Crux	Crucis	Cru	Cruc	12	60 S
Cygnus	Cygni	Cyg	Cygn	21	40 N
Delphinus	Delphini	Del	Dlph	21	10 N
Dorado	Doradus	Dor	Dora	5	65 S
Draco	Draconis	Dra	Drac	17	65 N
Equuleus	Equulei	Equ	Equl	21	10 N
Eridanus	Eridani	Eri	Erid	3	20 S
Fornax	Fornacis	For	Forn	3	30 S
Gemini	Geminorum	Gem	Gemi	7	20 N
Grus	Gruis	Gru	Grus	22	45 S
Hercules	Herculis	Her	Herc	17	30 N
Horologium	Horologii	Hor	Horo	3	60 S
Hydra	Hydrae	Hya	Hyda	10	20 S
Hydrus	Hydri	Hyi	Hydi	2	75 S
Indus	Indi	Ind	Indi	21	55 S
Lacerta	Lacertae	Lac	Lacr	22	45 N
Leo	Leonis	Leo	Leon	11	15 N
Leo Minor	Leonis Minoris	LMi	L Min	10	35 N
Lepus	Leporis	Lep	Leps	6	20 S
Libra	Librae	Lib	Libr	15	15 S
Lupus	Lupi	Lup	Lupi	15	45 S
Lynx	Lyncis	Lyn	Lync	8	45 N
Lyra	Lyrae	Lyr	Lyra	19	40 N
Mensa	Mensae	Men	Mens	5	80 S
Microscopium	Microscopii	Mic	Micr	21	35 S
Monoceros	Monocerotis	Mon	Mono	7	5 S
Musca	Muscae	Mus	Musc	12	70 S
Norma	Normae	Nor	Norm	16	50 S
Octans	Octantis	Oct	Octn	22	85 S
Ophiuchus	Ophiuchi	Oph	Ophi	17	0
Orion	Orionis	Ori	Orio	5	5 N
Pavo	Pavonis	Pav	Pavo	20	65 S
Pegasus	Pegasi	Peg	Pegs	22	20 N
Perseus	Persei	Per	Pers	3	45 N
Phoenix	Phoenicis	Phe	Phoe	1	50 S

[a]Old name; now divided into Carina, Puppis, and Vela.

TABLE V.—CONSTELLATIONS (*Continued*)

Constellation	Genitive	Abbreviation		Right Ascension, h	Declination, deg
Pictor	Pictoris	Pic	Pict	6	55 S
Pisces	Piscium	Psc	Pisc	1	15 N
Piscis Austrinus	Piscis Austrini	PsA	Psc A	22	30 S
Puppis	Puppi	Pup	Pupp	8	40 S
Pyxis (=Malus)	Pyxidis	Pyx	Pyxi	9	30 S
Reticulum	Reticuli	Ret	Reti	4	60 S
Sagitta	Sagittae	Sge	Sgte	20	10 N
Sagittarius	Sagittarii	Sgr	Sgtr	19	25 S
Scorpius	Scorpii	Sco	Scor	17	40 S
Sculptor	Sculptoris	Scl	Scul	0	30 S
Scutum	Scuti	Sct	Scut	19	10 S
Serpens (Cap. and Caud.)	Serpentis	Ser	Serp	17	0
Sextans	Sextantis	Sex	Sext	10	0
Taurus	Tauri	Tau	Taur	4	15 N
Telescopium	Telescopii	Tel	Tele	19	50 S
Triangulum	Trianguli	Tri	Tria	2	30 N
Triangulum Australe	Trianguli Australis	TrA	Tr Au	16	65 S
Tucana	Tucanae	Tuc	Tucn	0	65 S
Ursa Major	Ursa Majoris	UMa	U Maj	11	50 N
Ursa Minor	Ursa Minoris	UMi	U Min	15	70 N
Vela	Velorum	Vel	Velr	9	50 S
Virgo	Virginis	Vir	Virg	13	0
Volans	Volantis	Vol	Voln	8	70 S
Vulpecula	Vulpeculae	Vul	Vulp	20	25 N

constituent day. The duration of one rotation of the earth on its axis, with respect to an astre fictif, a fictitious star representing one of the periodic elements in the tidal forces. It approximates the length of a **lunar** or **solar day.**

construction weight. The weight of a **rocket** exclusive of propellant, load, and crew, if any. Also called *structural weight.*

continuity equation. In a **steady-flow** process, the mathematical statement of the principle of the **conservation of mass** by equating the flow at any section x, $\dot{w}_x$ to the flow at any section y, $\dot{w}_y$ or $\dot{w}_x = \dot{w}_y$

continuous absorption. See **absorption spectrum.**

continuous-flow system. An **oxygen system** in which the oxygen flows during both inspiration and expiration by the individual.

continuous-pressure breathing. A kind of **pressure breathing** in which a minimum amount of pressure variation exists inside the mask.

continuous spectrum. **1.** A **spectrum** in which wavelengths, wave numbers, and frequencies are represented by the continuum of real numbers or a portion thereof, rather than by a discrete sequence of numbers. See **discrete spectrum.** **2.** For **electromagnetic radiation,** a spectrum that exhibits no detailed structure and represents a gradual variation of intensity with wavelength from one end to the other, as the spectrum from an incandescent solid. Also called *continuum, continuum radiation.* **3.** For **particles,** a spectrum that exhibits a continuous variation of the momentum or energy.

continuous variable. A **variable** which can assume any value within a defined range.

continuous-wave radar. A general species of **radar** transmitting continuous waves, either modulated or unmodulated. The simplest form transmits a single frequency and detects only moving targets by the Doppler effect. This type of radar determines direction but usually not range. Also called *CW radar.* Compare **pulse radar.**

Two advantages of CW radar are the narrow bandwidth and low power required. Range information may be obtained by some form of modulation, e.g., frequency modulation, pulse modulation.

continuous waves (*abbr* **CW**). **Waves,** the successive oscillations of which are identical under steady-state conditions.

continuum. **1.** Something which is continuous, which has no discrete parts, as the *continuum of real numbers* as opposed to the sequence of discrete integers, as the *background continuum*

of a **spectrogram** due to thermal radiation. **2.** = **continuous spectrum.**

continuum flow. See **rarefied gas dynamics.**

continuum radiation = **continuous spectrum.**

contrail = **condensation trail.**

contrast. **1.** In general, the degree of differentiation between different tones in an image.

Where the degree is slight, the image is said to be *flat*. Where the difference is marked, it is said to be *contrasty*.

2. The difference in luminance between two portions of the visual field usually expressed as:

$$c = \frac{\text{background} - \text{test field}}{\text{background}} \times 100\%$$

Since this ratio can be negative for nearly black targets at close range, and since the sign of the contrast has no psycho-physical significance, it is conventional to use only its absolute value. See **threshold contrast.**

contrast threshold = **threshold contrast.**

contravane. A vane that reverses or neutralizes rotation of a **flow.** Also called a *countervane.*

control. **1.** A lever, switch, cable, knob, pushbutton, or other device or apparatus by means of which direction, regulation, or restraint is exercised over something. **2.** In plural **(a)** A system or assembly of levers, gears, wheels, cables, boosters, valves, etc., used to control the attitude, direction, movement, power, and speed of an aircraft, rocket, spacecraft, etc. **(b)** Control surfaces or devices. **3.** Sometimes capitalized. An activity or organization that directs or regulates an activity. See **central control. 4.** Specifically, to direct the movements of an aircraft or rocket with particular references to changes in attitude and speed. Compare **guidance.**

control feel. The impression of the stability and control of an aircraft that a pilot receives through the cockpit **controls,** either from the **aerodynamic forces** acting on the control surfaces or from forces simulating these aerodynamic forces. See **artificial feel, feel.**

controllability. The capability of an aircraft, rocket, or other vehicle to respond to **control,** especially in direction or attitude.

controlled environment. The **environment** of any object, such as an instrument, a man, or an unlaunched rocket, in which effects such as humidity, pressure, temperature, etc., are maintained at predetermined levels.

controlled-leakage system. A system that provides for the maintenance of life in an aircraft or spacecraft cabin by a controlled escape of carbon dioxide and other waste from the cabin, with replenishment provided by stored oxygen and food. Compare **closed ecological system.**

control rocket. A **vernier engine, retrorocket,** or other such rocket, used to change the attitude of, guide, or make small changes in the speed of a rocket, spacecraft, or the like.

control unit. That part of a **computer** which causes the **arithemetic unit, storage,** and transfer of a computer to operate in proper sequence.

control vane. A movable **vane** used for **control,** especially a movable **air vane** or **jet vane** on a rocket, used to control flight attitude.

convection. 1. In general, mass motions within a **fluid** resulting in transport and mixing of the properties of that fluid. Compare **conduction, radiation. 2.** Specifically, in meteorology, atmospheric motions that are predominantly vertical. Compare **advection.**

convective atmosphere = **adiabatic atmosphere.**

convergence. 1. The contraction of a vector field; also, a precise measure thereof. Compare **confluence.**

Mathematically, convergence is negative divergence, and the latter term is used for both. (For mathematical treatment, see **divergence.**)

2. The property of a sequence or series of numbers or functions which ensures that it will approach a definite finite limit.

A series representation of a mathematical function exhibits convergence if the sum of the terms of the series approaches the value of the function more closely as more terms of the series are taken, the two agreeing in the limit of an infinite number of terms.

3. Decrease in area or volume.

conversion device. In computer terminology, any device for changing the manner of representing information. Also called a *converter.*

convert. In computer terminology, **(a)** to change the manner of representing information, e.g., from analog to digital; **(b)** to translate the medium of conveying or storing information, e.g., from punched cards to magnetic tape; **(c)** to change **numeric** information from one **notation** to another.

converter. 1. A rotary device for changing alternating current to direct current.

A static device for this purpose is called a *rectifier*. A device for changing direct current to alternating current is called an *inverter*.

2. A transducer whose output is a different frequency from its input. **3.** In computer terminology = **conversion device.**

convertiplane. A hybrid form of heavier-than-air aircraft that is capable, by virtue of one or more horizontal rotors or units acting as rotors, of taking off, hovering, and landing as, or in a

fashion similar to, a helicopter, and once aloft, and moving forward, capable, by means of a mechanical conversion of one sort or another, of flying purely as a fixed-wing aircraft, especially in its higher speed ranges.

coolant (*symbol* **c** *used as subscript*). A **liquid** or **gas** used to cool something, as a rocket combustion chamber.

This word is used in many self-explanatory compounds, which include: *coolant* chamber, *coolant* gallery, *coolant* hose, *coolant* jacket, *coolant* passage, *coolant* pump, *coolant* radiator.

cooled-tube pyrometer. A **thermometer** for high-temperature flowing gases that uses a liquid-cooled tube inserted in the flowing gas; gas temperature is deduced from the law of convective heat transfer to the outside of the tube and from measurement of the mass flow rate and temperature rise of the cooling liquid.

cooler. See **radiator,** note.

cooling power. In the study of human bioclimatology, one of several parameters devised to measure the air's cooling effect upon a human body.

coordinate. One of a set of measures defining a point in space.

If the point is known to be on a given line, only one coordinate is needed; if on a surface, two are required; if in space, three. Cartesian coordinates define a point relative to two intersecting lines, called *axes*. If the axes are perpendicular, the coordinates are rectangular; if not perpendicular, they are oblique coordinates. A three-dimensional system of Cartesian coordinates is called space coordinates. Polar coordinates define a point by its distance and direction from a fixed point called the *pole*. Direction is given as the angle between a reference **radius vector** and a radius vector to the point. If three dimensions are involved, two angles are used to locate the radius vector. Space-polar coordinates define a point on the surface of a sphere by (1) its distance from a fixed point at the center, the pole; (2) the colatitude or angle between the polar axis (a reference line through the pole) and the radius vector (a straight line connecting the pole and the point); and (3) the longitude or angle between a reference plane through the polar axis and a plane through the radius vector and the polar axis. Spherical coordinates define a point on a sphere or spheroid by its angular distances from a primary great circle and from a reference secondary great circle. Geographical or terrestrial coordinates define a point on the surface of the earth. Celestial coordinates define a point on the celestial sphere.

Table VI summarizes the terms used in four geocentric celestial coordinate systems and the terrestrial (geographic) coordinate system and indicates the analogous terms under each system.

coordinate axes. See **Cartesian coordinates.**

coordinate line. See **curvilinear coordinates.**

coordinate planes. See **Cartesian coordinates.**

coordinate surface. See **curvilinear coordinates.**

coordinate system. Any scheme for the unique identification of each point of a given **continuum.** The geometry of the system is a matter of convenience determined by the boundaries of the continuum or by other considerations. Also called *reference frame.*

TABLE VI.—TERRESTRIAL AND CELESTIAL COORDINATE SYSTEMS[a]

Terrestrial (*long*, *lat*)	Celestial equator (α, δ)	Horizon (h, Zn)	Ecliptic (λ, β)	Galactic (l, b)
equator	celestial equator	horizon	ecliptic	galactic equator
poles	celestial poles	zenith, nadir	ecliptic poles	galactic poles
meridians	hour, circles, celestial meridians	vertical circles	circles of latitude	
prime meridian	hour circle through ♈[b], Greenwich celestial meridian, local celestial meridian	principal vertical circle, prime vertical circle	circle of latitude through ♈[b]	great circle through galactic poles so that angle θ to celestial north pole is 123°
parallels	parallels of declination	parallels of altitude	parallels of latitude	
latitude (L, *lat*)	declination (δ, d)	altitude (h)	celestial latitude (β)	galactic latitude (b)
colatitude	polar distance	zenith distance	celestial colatitude	galactic colatitude
longitude (λ, *long*)	sidereal hour angle (*SHA*) right ascension (*RA*, α) Greenwich hour angle (*GHA*) local hour angle (*LHA*)	azimuth (Zn) azimuth angle	celestial longitude (λ)	galactic longitude (l)

[a] For definitions of terms, see individual entries.
[b] ♈ = first point of Aries

copy. To reproduce information without changing it.

Cor A. International Astronomical Union abbreviation for *Corona Austrina.* See **constellation.**

Cor B. International Astronomical Union abbreviation for *Corona Borealis.* See **constellation.**

coriolis acceleration. An **acceleration** of a particle moving in a **relative coordinate system.** The total acceleration of the particle, as measured in an **inertial coordinate system,** may be expressed as the sum of the acceleration within the relative system, the acceleration of the relative system itself, and the coriolis acceleration.

Physically, coriolis acceleration may be considered as coming from the conservation of momentum in a body moving in a direction not parallel to the axis of rotation of the relative system.

Mathematically, coriolis acceleration comes from the differentiation of terms containing the angular velocity ω in the expression for the absolute velocity of the particle.

In the case of the earth, moving with angular velocity ω, a particle moving relative to the earth with velocity v has the coriolis acceleration $2\omega \times v$. If Newton laws are to be applied in the relative system, the coriolis acceleration and the acceleration of the relative system must be treated as forces. See **apparent force, coriolis force, inertial force, gravity.**

coriolis correction. A correction applied to an assumed position, celestial **line of position,** celestial fix, or to a computed or observed altitude to allow for apparent acceleration due to **coriolis acceleration.**

coriolis effects. The physiological effects (nausea, vertigo, dizziness, etc.) felt by a person moving radially in a rotating system, as a rotating space station.

coriolis force. An inertial force on a moving body, or particles, produced by the movement of the masses involved, perpendicular to the axis of the primary rotating system. Also called *compound centrifugal force, deflecting force.* See **inertial force, coriolis acceleration.**

Such a force is required if Newton laws are to be applied in the system.

coriolis parameter. Twice the component of the earth's angular velocity about the **local vertical,** $2\omega \sin \varphi$, where ω is the angular speed of the earth and φ is the latitude.

corner reflector. In radar, three conducting surfaces mutually intersecting at right angles designed to return electromagnetic radiations toward their sources and used to render a position more conspicuous to **radar** observations.

corona. 1. The outer visible envelope of the sun. Also called *solar corona.*

It is observed at solar eclipse or with the **coronagraph.** The shape of the corona varies during the sunspot cycle. At sunspot minimum the corona has large extensions along the sun's equator, with short brushlike tufts near the poles. At sunspot maximum the equatorial extensions are much smaller and the corona is more regular in shape. The temperature of the corona appears to be in the vicinity of 1,000,000° K.

2. The extremely tenuous outer atmosphere of the sun now known to extend past the earth's orbit. **3.** A set of one or more prismatically colored rings of small radii, concentrically surrounding the disk of the sun, moon, or other luminary when veiled by a thin cloud.

The corona is due to **diffraction** by numerous water drops. It can be distinguished from the relatively common halo of 22° by the much smaller angular diameter of the corona, which is often only a few degrees, and by its color sequence, which is from blue inside to red outside, the reverse of that in the 22° halo.

4. See **corona discharge. 5.** See **aurora. 6.** See **geocorona.**

Corona Australis = Corona Austrina (*abbr* **CrA, Cor A**). See **constellation.**

Corona Borealis (*abbr* **CrB, Cor B**). See **constellation.**

corona discharge. A luminous, and often audible, **electric discharge** that is intermediate in nature between a **spark discharge** (with, usually, its single discharge channel) and a **point discharge** (with its diffuse, quiescent, and nonluminous character). Also called *brush discharge, St. Elmo's fire, corposant.*

coronagraph. An instrument for photographing the **corona** and **prominences** of the sun at times other than at solar eclipse. An occulting disk is used to block out the image of the body of the sun in the focal plane of the objective lens. The light of the corona passes the occulting disk and is focused on a photographic film.

Great care must be taken to avoid light scattered from the atmosphere and the lenses, and from reflections in the tube of the instrument. The coronagraph is used with a narrow-band polarizing filter or with a spectroscope.

corposant = corona discharge.

corpuscular. Consisting of **particles,** specifically atomic particles.

corpuscular cosmic rays. Primary cosmic rays from outer space which consist mainly of protons with energies of 2–20 billion electron volts (Bev).

For 1000 protons there are about 80 helium nuclei, about 3 nuclei in the carbon-nitrogen-oxygen range, and 1 or 2 heavier nuclei. The proton energy may be as high as 10^5 Bev, and the other nuclei show an energy distribution similar to that of the protons.

corpuscular theory of light. The hypothesis, by Sir Isaac Newton, that light consists of a stream of minute particles emitted by luminous bodies at very high velocities, and that the sensation of light, is due to the bombardment of the retina of the eye by these particles.

Although this theory was later replaced by the **wave theory of light,** the concept of photons in the modern quantum theory is reminiscent of Newton theory.

correction. A quantity, equal in absolute magnitude to the **error,** added to a calculated or observed value to obtain the true value.

correlation. **1.** In statistics, a relationship between two occurrences which is expressed as a number between minus one (-1) and plus one ($+1$). **2.** When used without further qualification, the statistical term *correlation* usually refers to simple, linear correlation between two variables x and y and is measured by the product-moment coefficient of correlation ρ or its sample estimate r defined as follows, where the respective population mean values of x and y are denoted by ξ and ζ, the respective standard deviations by $\sigma(x)$ and $\sigma(y)$, and where E is the expected value:

$$\rho = \frac{E[(x - \xi)\ (y - \zeta)]}{\sigma(x)\sigma(y)}$$

$$\mathrm{r} = \frac{\Sigma(x_i - \bar{x})\ (y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2\Sigma(y_i - \bar{y})^2}}.$$

The product-moment $E[(x - \xi)\ (y - \zeta)]$ is usually called the *covariance of x and y.* See **autocorrelation, multiple correlation, partial correlation.**

In connection with correlation, the word *simple* is used in contradistinction to other qualifiers such as *multiple* or *partial.* The word *linear* refers to a linear relationship between the two variables, or more precisely, to a linear approximation of the **regression function** of either variable with respect to the other.

correlation coefficient. **1.** See **correlation,** sense **2.** **2.** A measure of the persistence of **eddy velocity** as a function of time and space.

correlation detection. A method of **detection** in which a **signal** is compared, point-to-point, with an internally generated reference. Also called *cross correlation detection.*

The output of such a detector is a measure of the degree of similarity of the input and reference signals. The reference signal is constructed in such a way that it is at all times a prediction, or best guess, of what the input signal should be at that time.

correlation tracking and ranging (*abbr* **Cotar**). A nonambiguous trajectory-measuring system using short-baseline, single-station, continuous-wave phase-comparison measuring two **direction cosines** and a **slant range.**

correlation tracking and triangulation (*abbr* **Cotat**). A **trajectory measuring system** composed of several antenna baselines, each separated by large distances, used to measure **direction cosines** to an object.

From these measurements its space position is computed by triangulation.

correlation tracking system. A **trajectory measuring system** utilizing correlation techniques where signals derived from the same source are correlated to derive the **phase difference** between the signals.

This phase difference contains the system data.

corrosion. The deterioration of a metal by chemical or electrochemical reaction with its environment.

Corv. International Astronomical Union abbreviation for *Corvus.* See **constellation.**

Corvus (*abbr* **Crv, Corv**). See **constellation.**

cosine law of illumination. A purely geometric relationship between the **illuminance** of a surface and the angle of incidence of the illuminating rays. Mathematically, the illuminance I of the surface illuminated by a beam of flux density F incident at angle θ is

$$I = F \cos \theta$$

The marked latitudinal variation in **insolation** on the earth is largely a consequence of this simple relationship. Compare **Lambert law.**

cosmic. Of or pertaining to the universe, especially that part of it outside the earth's atmosphere. Used by the USSR as equivalent to space, as in *cosmic rocket, cosmic ship.*

cosmic dust. Finely divided solid matter with particle sizes smaller than a **micrometeorite,** thus with diameters much smaller than a millimeter, moving in interplanetary space. See **dust.**

Cosmic dust in the solar system is thought to be concentrated in the plane of the ecliptic, thus causing the **zodiacal light.**

cosmic noise. Interference caused by **cosmic radio waves.**

cosmic radiation = **cosmic rays.**

cosmic radio waves. Radio **waves** emanating from extraterrestrial sources.

They are *galactic radio waves* if their origin is within our galaxy and *extragalactic radio waves* if their origin is outside our galaxy. *Solar radio waves* emanate from the sun.

cosmic-ray burst. An extensive production of ionization from a common origin by **cosmic rays** in a recording device such as a **cloud chamber.**

cosmic-ray knee. The point of sudden dropoff in the intensity of recorded **cosmic rays** at about 40 degrees **geomagnetic latitude.**

The dropoff is due to the shielding effect of the earth's magnetic field.

cosmic rays. The aggregate of extremely high-energy subatomic **particles** which travel the solar system and bombard the earth from all

directions. Cosmic-ray primaries seem to be mostly protons, hydrogen nuclei, but also contain heavier nuclei. On colliding with atmospheric particles they produce many different kinds of lower energy **secondary cosmic radiation** (see **cascade shower**). Also called *cosmic radiation.*

Cosmic rays thought to originate outside the solar system are called *galactic cosmic rays.* Those thought to originate in the sun are called *solar cosmic rays.*

In the earth's atmosphere, the maximum flux of cosmic rays, both primary and secondary, is at an altitude of 20 km, and below this the absorption of the atmosphere reduces the flux, though the rays are still readily detectable at sea level. Intensity of cosmic-ray showers has also been observed to vary with latitude, being more intense at the poles. See **cosmic-ray knee, corpuscular cosmic rays.**

cosmonaut. A Soviet astronaut, sense 1.

COSPAR (*abbr*) = **Committee on *Space* *Research*, International Council of Scientific Unions.**

coulomb (*abbr* **C**). The unit of quantity of electricity; the quantity of electricity transported in 1 second by a current of 1 **ampere.**

Cotar (*abbr*) = ***correlation tracking and ranging.***

Cotat (*abbr*) = ***correlation tracking and triangulation.***

Couette flow. The shearing flow of a **fluid** between two parallel surfaces in relative motion. A two-dimensional steady flow without pressure gradient in the direction of flow and caused by the tangential movement of the bounding surfaces. The only practical type is the flow between concentric rotating cylinders (as of the oil in a cylindrical bearing).

Coulomb collision. The collision of two **particles** both of which are charged.

In this case the **collision cross section** is considerably larger than when one of the particles is neutral because the electric field of the two particles can interact at much larger distances. Since the collisions are distant ones, however, the particles will suffer only a small angular deviation.

Coulomb damping. The dissipation of energy that occurs when a particle in a vibrating system is resisted by a force whose magnitude is a constant independent of displacement and velocity, and whose direction is opposite to the direction of the velocity of the particle. Also called *dry friction damping.*

count. **1.** To proceed from one point to another in a countdown or plus count, normally by calling a number to signify the point reached; to proceed in a countdown, as in *T minus 90 and counting.* Compare **hold.** **2.** In radiation counters, a single response of the counting system.

countdown. **1.** A step-by-step process that culminates in a climactic event, each step being performed in accordance with a schedule marked by a count in inverse numerical order; specifically, this process is used in leading up to the launch of a large or complicated rocket vehicle, or in leading up to a captive test, a readiness firing, a mock firing, or other firing test. **2.** The act of counting inversely during this process.

In sense **2,** the countdown ends with T-time; thus, *T minus 60 minutes* indicates there are 60 minutes to go, excepting for holds and recycling. The countdown may be hours, minutes, or seconds. At the end, it narrows down to seconds, 4–3–2–1–0. See **plus count.**

counter. A device capable of changing from one to the next of a sequence of distinguishable states upon each receipt of an **input signal.** Also called *accumulator.*

counterclockwise polarized wave = **left-handed polarized wave.**

counterglow = **gegenschein.**

counterpressure. A pressure applied to the exterior of the human body to counteract a pressure introduced inside during **pressure breathing.**

counterradiation. The downward **flux** of **atmospheric radiation** passing through a given level surface, usually taken as the earth's surface. Also called *back radiation.*

This result of infrared (long-wave) absorption and reemission by the atmosphere is the principal factor in the **greenhouse effect.**

countervane = **contravane.**

coupled modes. Modes of **vibration** that are not independent but which influence one another because of energy transfer from one mode to the other.

coupling. **1.** A device or contrivance for joining adjacent ends or parts of anything. **2.** A device permitting transfer of **energy** from one electrical circuit to another, or from one mechanical device to another.

course. **1.** A predetermined or intended route or direction to be followed, measured with respect to a geographic reference direction; a line on a chart representing a course. **2.** A line of flight taken by an aircraft, rocket, etc. **3.** A **radio beam** in a radio range.

course line. **1.** A **line of position** plotted on a chart, parallel or substantially parallel to the intended course of a craft, showing whether the craft is to the right or the left of its course. **2.** Any line representing a course.

Cowell method. A method of **orbit** computation using direct step-by-step integration in rectangular coordinates of the total acceleration of the orbiting body.

The Cowell method is a **special perturbation method.**

CrA, Cor A. International Astronomical Union abbreviations for *Corona Australis.* See **constellation.**

cracking. Presence of relatively large cracks extending into the interior of a structure, usually produced by overstressing the structural material. Compare **checking.**

craft. **1.** An aircraft, or aircraft collectively. **2.** Any vehicle or machine designed to fly through air or space.

Crat. International Astronomical Union abbreviation for *Crater.* See **constellation.**

Crater (*abbr* **Crt, Crat**). See **constellation.**

crater. **1.** = **lunar crater.** **2.** The depression resulting from high speed solid particle impacts on a rigid material as a **meteoroid** impact on the skin of a spacecraft.

craterlets. See **lunar crater,** note.

CrB, Cor B. International Astronomical Union abbreviations for *Corona Borealis.* See **constellation.**

creep. The slow but continuous deformation of a material under constant load or prolonged **stress** (usually critically encountered at elevated temperatures).

creep strength. The constant nominal **stress** that will cause a specified quantity of **creep** in a given time at constant temperature.

crescent. See **phases of the moon.**

crippled leapfrog test. In computer operations, a modified **leapfrog test** in which tests are repeated from a single set of **storage** locations and do not *leap* to another set of storage locations.

critical. In reactor theory, capable of sustaining a **chain reaction.** See **critical reactor.**

critical damping. The minimum **damping** that will allow a displaced system to return to its initial position without **oscillation.**

critical frequency. The limiting **frequency** below which a **magnetoionic wave component** is reflected by, and above which it penetrates through, an ionized medium (**plasma**) at vertical incidence.

criticality factor. As applied to a reactor, the numerical value of the **effective multiplication factor** (k_e), denoting the degree to which the **reactor** has achieved a self-sustaining **chain reaction.**

critical level = **critical level of escape.**

critical level of escape. That level, in the atmosphere, at which a particle moving rapidly upwards will have a probability of $1/e$, where e is base of natural logarithm, of colliding with another particle on its way out of the atmosphere. It is also the level at which the horizontal **mean free path** of atmospheric particle equals the **scale height** of the atmosphere. The critical level of escape is the base of the **exosphere.** Also called *level of escape, critical level.* See **cone of escape, fringe region.**

Estimates of the height of the critical level of escape range from about 500 to 1000 kilometer. This large range of estimated values is due primarily to the general uncertainty about the temperature distribution in the ionosphere.

critical Mach number. The **free-stream** Mach number at which a local **Mach number** of 1.0 is attained at any point on the body under consideration.

For example, an airplane traveling at a Mach number of 0.8 with respect to the undisturbed flow might attain a Mach number of 1 in the flow about the wing; the critical Mach number would thus be 0.8.

critical mass. The amount of concentrated **fissionable** material that can just support a self-sustaining **fission** reaction.

critical point. The **thermodynamic** state in which liquid and gas **phases** of a substance coexist in equilibrium at the highest possible temperature. At higher temperatures than the critical no liquid phase can exist. For water substance the critical point is

$$P_s = 2.21 \times 10^5 \text{ millibars}$$
$$T = 647° \text{ K}$$
$$v = 3.10 \text{ grams/cubic centimeter}$$

where P_s is the saturation vapor pressure of the water vapor; T is the Kelvin temperature; and v is the specific volume.

critical pressure. **1.** In rocketry, the pressure in the **nozzle throat** for which the isentropic **weight flow rate** is a maximum. **2.** The pressure of a gas at the **critical point,** which is the highest pressure under which a liquid can exist in equilibrium with its vapor.

critical reactor. The steady-state condition of a **reactor** in which the neutron **fission** process is self-sustaining without the aid of external neutron sources. A critical reactor has a **criticality factor** of one ($k_e = 1$).

critical Reynolds number. The **Reynolds number** at which some significant change occurs, e.g., the Reynolds number at which a transition from **laminar** to **turbulent flow** begins, or at which the **drag** of a cylinder or sphere drops sharply.

critical speed. A speed of a rotating system that corresponds to a **resonance frequency** of the system.

critical temperature. 1. The **temperature** above which a substance cannot exist in the **liquid** state, regardless of the pressure. 2. As applied to reactor overheat or **afterheat**, the temperature at which the least resistant component of the **reactor core** begins to melt down. 3. As applied to materials, the temperature at which a change in phase takes place causing an appreciable change in the properties of the material.

critical throat velocity = **critical velocity.**

critical velocity. In rocketry, the **speed of sound** at the conditions prevailing at the **nozzle throat.** Also called *throat velocity, critical throat velocity.*

cross correlation detection = **correlation detection.**

crossflow. A **flow** going across another flow, as a spanwise flow over a wing.

crossflow plane. In aerodynamics, a plane at right angles to the **free-stream** velocity. Compare **crossflow.**

crosshair. A hair, thread, or wire constituting part of a **reticle.**

cross modulation. In general, **modulation** of a desired **signal** by an undesired signal.

crosspatching. See **supercommutation.**

cross product = **vector product.**

cross section. 1. A measure of the effectiveness of a particular process expressed either as an area (geometric cross section) which would produce the observed result, or as a ratio. See **absorption cross section, scattering cross section.** 2. = **nuclear cross section.**

cross sensitivity. The ratio of change in output to an incremental change in a given stimulus along any axis perpendicular to the sensitive axis.

In accelerometers it refers to the change in the transducer output at zero acceleration and at some other acceleration value applied along a plane perpendicular to the sensitive axis.

crosstalk. Electrical disturbances in a communication channel as a result of **coupling** with other communication channels.

crosswind. That wind vector component which is perpendicular to the course of an exposed moving object. Compare **range wind.**

Crt, Crat. International Astronomical Union abbreviations for *Crater.* See **constellation.**

Cruc. International Astronomical Union abbreviation for *Crux.* See **constellation.**

Crux (*abbr* **Cru, Cruc**). See **constellation.**

CRT (*abbr*). **Cathode ray tube.**

Crv, Corv. International Astronomical Union abbreviations for *Corvus.* See **constellation.**

cryogenic materials. Those metals and alloys which are usable in structures operating at very low temperature, and usually possess improved strength properties at these temperatures.

cryogenic propellant. A rocket **fuel, oxidizer,** or propulsion fluid which is liquid only at very low temperatures.

cryogenic pump. A type of pump which uses **cryopumping** to attain a vacuum.

cryogenics. 1. The study of the methods of producing very low temperatures. 2. The study of the behavior of materials and processes at cryogenic temperatures.

cryogenic temperature. In general, a temperature range below the boiling point of nitrogen (−195° C); more particularly, temperatures within a few degrees of absolute zero.

cryopump. 1. An exposed surface refrigerated to **cryogenic temperature** for the purpose of pumping gases in a vacuum chamber by condensing the gas and maintaining the condensate at a temperature such that the equilibrium vapor pressure is equal to or less than the desired ultimate pressure in the chamber. 2. The act of removing gases from an enclosure by condensing the gases on surfaces at cryogenic temperature.

Also referred to as a *cryogenic pump* and not to be confused with a *cryogenic fluid pump* for circulating *cryogenic propellants.*

cryopumping. The process of removing gas from a system by condensing it on a surface maintained at very low temperatures.

cryotron. A device based upon the principle that **superconductivity** established at temperatures near absolute zero is destroyed by the application of a magnetic field.

crystal lattice. The three-dimensional, recurring pattern in which the atoms of a crystal are arranged.

crystal transducer. A **transducer** in which the method of transduction is accomplished by means of the **piezoelectric** properties of certain crystals or salts. Also called *crystal.*

C-scan = **C-display.**

C-scope = **C-display.**

culmination = **transit** (sense 1), specifically **upper transit.**

curie (*abbr* **C**). The unit of the rate of **radioactive** decay; the quantity of any radioactive **nuclide** which undergoes 3.70×10^{10} disintegrations per second.

Curie point. The temperature in a **ferromagnetic** material above which the material becomes substantially nonmagnetic.

Curie temperature = **Curie point.**

curl. A **vector** operation upon a vector field which represents the rotation of the field, related to the circulation of the field at each point. The curl is invariant with respect to coordinate transformations and is usually written "curl F" or "$\nabla \times$ F" where ∇ is the del-operator. In Cartesian coordinates, if F has the components F_x, F_y, F_z the curl is

$$\left(\frac{\partial F_z}{\partial y} - \frac{\partial F_y}{\partial z}\right)\mathrm{i} + \left(\frac{\partial F_x}{\partial z} - \frac{\partial F_z}{\partial x}\right)\mathrm{j} + \left(\frac{\partial F_y}{\partial x} - \frac{\partial F_x}{\partial y}\right)\mathrm{k}$$

Expansions in other coordinate systems may be found in any text on vector analysis.

The curl of a two-dimensional vector field is always in a field of solid rotation it is equal to twice the angular velocity. Occasionally the vorticity is defined as one-half the curl.

The curl of a two dimensional vector field is always normal to the vectors of the field; this is not necessarily true in three dimensions. Compare **divergence.**

cursor. A device used with an instrument to provide a movable reference, as the runner of a slide rule or a rotatable plastic disk with inscribed crosslines, used in reading bearings on a **plan position indicator.**

Curtis turbine. A **turbine** in which a stationary set of blades is used to change the direction of the fluid flow as the fluid travels between two sets of rotating blades.

curved-path error. The difference between the length of a **ray** refracted by the **atmosphere** and the straight-line distance between the ends of the ray.

curve of growth. In spectroscopy, the relationship between the amount of **radiant energy** removed by an **absorption line** and the number of atoms or molecules of the absorbing gas in the light path.

If the logarithm of energy absorbed is plotted against the logarithm of amount of gas in the path, the resulting curve of growth usually has two straight-line segments. The first, for small absorption and small amounts of gas, has a slope of 1; the second, for large absorption and large amounts of gas, has a slope of $\frac{1}{2}$. Thus, initially absorption is directly proportional to the number of atoms or molecules, but as the line becomes more intense, absorption becomes proportional to the square root of the number of atoms or molecules. Between these two straight-line segments there is often a portion in which an increase in the amount of gas in the path produces very little increase in total absorption. All of this discussion applies in the case of gaseous **emission** as well as **absorption.**

curve of regression. A realistic curve having a **least-squares** fit to the data points.

There are an infinity of least-squares curves to fit a set of data points (one curve of which touches every point). Therefore, the regression curve must be the best least-squares estimate (of the true curve of the phenomenon observed) that can be made in light of the data and prior knowledge of the physics of the phenomenon observed. Note that a regression curve is offset from the true curve by the amount of any bias error and of most systematic errors.

curvilinear coordinates. Any linear **coordinates** which are not **Cartesian coordinates.** Examples of frequently used curvilinear coordinates are **polar coordinates** and **cylindrical coordinates.** See **natural coordinates, spherical coordinates.**

cutoff or **cut-off. 1.** An act or instance of shutting something off; specifically, in rocketry, an act or instance of shutting off the **propellant** flow in a rocket, or of stopping the **combustion** of the propellant. Compare **burnout. 2.** Something that shuts off, or is used to shut off. See **fuel shutoff. 3.** Limiting or bounding as in *cutoff frequency*.

CVn, C Ven. International Astronomical Union abbreviations for *Canes Venatici*. See **constellation.**

CW radar = **continuous-wave radar.**

CW system. A **trajectory measuring system** that utilizes a **continuous-wave** signal to obtain information on the trajectory of a target.

cyanometer. An instrument designed to measure or estimate the blueness of the sky.

The type in most common use is the **Linke scale.**

cyanometry. The study and measurement of the blueness of the sky.

The characteristic blue color of clear skies is due to preferential **scattering** of the short wavelength components of visible sunlight by air molecules. Presence of foreign particles in the atmosphere alters the scattering processes in such a way as to reduce the blueness. Hence spectral analysis of **diffuse sky radiation** provides useful information concerning the scattering particles.

cybernetics. The study of methods of **control** and communication which are common to living organisms and machines.

cycle (*symbol* c). **1.** The complete sequence of values of a **periodic quantity** that occur during a period. **2.** One complete wave, a **frequency** of 1 **wave** per second. **3.** Any repetitive series of operations or events.

cycle efficiency. The efficiency of a given **cycle** in an internal combustion engine, in producing work, expressed as the useful work output divided by the work input. For a gas-turbine engine, the cycle efficiency is the useful work energy less the work required for compression divided by the heat energy in the fuel used; for a reciprocating engine, it is the energy of the indicated horsepower divided by the heat energy of the fuel.

cyclic. Of or pertaining to a **cycle** or cycles.

cyclic code. In computer operations, a **positional notation,** not necessarily binary, in which quantities differing by one unit are represented by expressions which are identical except for one place or column, and the digits in that place or column differ by only one unit. Also called *reflected code.* See **Gray code.**

cyclonic. Having a sense of **rotation** about the **local vertical** the same as that of the earth's rotation: that is, as viewed from above, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere, undefined at the equator; the opposite of **anticyclonic.**

cyclophon. A name given to a generic type of **vacuum tube** utilizing a beam of electrons as a switching or commutating element.

cyclotron. A device for accelerating charged **particles** to high energies by giving particles traveling in a spiral path successive increments of energy from an alternating electric field between electrodes placed in a constant magnetic field. The path radius increases as energy increases.

cyclotron frequency. The **frequency** at which a charged **particle** orbits in a uniform magnetic field. It depends on the charge to mass ratio of the particle times the magnetic field. While the frequency is independent of the particle energy, the **Larmor orbit** increases with energy. Sometimes called the *Larmor frequency.*

In a magnetic field of 1 gauss, the electron cyclotron frequency is 2.8 megacycles per second and the proton cyclotron frequency is 1.5 kilocycles per second.

cyclotron radiation. The **electromagnetic radiation** emitted by charged **particles** as they orbit in a magnetic field. The radiation arises from the **centripetal acceleration** of the particle as it moves in a circular orbit. See **Larmor orbit.**

When the velocity is small, the radiation is concentrated in a single spectral line, at the **cyclotron frequency.** The spectral line is spread into a band of frequencies, however, from the effects of Doppler, Stark, and collision broadening. In addition, as the speed of the particles approaches the velocity of light, higher harmonics of the cyclotron radiation occur at multiples of the cyclotron frequency.

cyclotron resonance. Energy transfer to charged **particles** in a magnetic field from an alternating-current electric field whose frequency is equal to the **cyclotron frequency.**

An analogous physical situation is the large increase in the motion of a pendulum if it is given a little push in every period of its natural oscillation. Such a technique is useful in heating either the electrons or ions.

Cyg, Cygn. International Astronomical Union abbreviations for **Cygnus.** See **constellation.**

Cygnus (*abbr* **Cyg, Cygn**). See **constellation.**

cylindrical coordinates. A system of **curvilinear coordinates** in which the position of a point in space is determined by (**a**) its perpendicular distance from a given line, (**b**) its distance from a selected reference plane perpendicular to this line, and (**c**) its angular distance from a selected reference line when projected onto this plane. The coordinates thus form the elements of a cylinder, and, in the usual notation, are written r, θ, and z where r is the radial distance from the cylinder's axis z, and θ is the angular position from a reference line in a cylindrical cross section normal to z. Also called *cylindrical polar coordinates, circular cylindrical coordinates.* See **polar coordinates.**

The relations between the cylindrical coordinates and the rectangular Cartesian coordinates (x, y, z) are $x = r \cos \theta$, $y = r \sin \theta$, $z = z$.

cylindrical polar coordinates = **cylindrical coordinates.**

cylindrical wave. A wave in which the wave fronts are coaxial cylinders.

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D

dabble. See **double-dabble.**

Dalton = **atomic mass unit.**

Dalton law. The empirical generalization that for many so-called **perfect gases,** a mixture of these gases will have a pressure equal to the sum of the partial pressures that each of the gases would have as sole component with the same volume and temperature, provided there is no chemical interaction.

Dalton law of partial pressure = **Dalton law.**

damp. To suppress **oscillations** or disturbances.

damped natural frequency. The frequency of free **vibration** of a damped linear system.

The oscillation of a damped system may be considered periodic in the limited sense that the time interval between zero crossings in the same direction is constant if the system is linear, even though successive amplitudes decrease progressively. The frequency of the oscillation is the reciprocal of this time interval. The damped natural frequency decreases as the damping increases, and approaches zero as the damping approaches *critical damping.*

damped wave. Any **wave** whose **amplitude** decreases with time or whose total energy decreases by transfer to other portions of the wave spectrum.

damping. The suppression of **oscillations** or disturbances; the dissipation of **energy** with time. See **viscous damping.**

damping factor. The ratio of the **amplitude** of any one of a series of damped **oscillations** to that of the following one at the same phase.

damping ratio. The ratio of actual **damping** to **critical damping.**

It may be expressed as the ratio of output under static conditions to twice the output at the lowest frequency where a 90° phase shift is observed.

dark adaptation. The process by which the iris and retina of the eye adjust to allow maximum vision in dim illumination, following exposure of the eye to a relatively brighter illumination.

dark blips. See **dark trace tube.**

dark trace tube. A **cathode-ray tube,** on which the face is bright, and signals are displayed as dark **traces** or dark **blips.**

dart configuration. A **configuration** of an **aerodynamic vehicle** in which the control surfaces are at the tail of the vehicle. Contrast *canard.*

data-acquisition station. A ground station at which various functions to **control** satellite operations and to obtain data from the **satellite** are performed.

data link. Any communications **channel** or circuit used to transmit data from a **sensor** to a **computer,** a **readout** device, or a **storage** device.

data point. A unit of fundamental information obtained through the processing of raw data.

data processing. Application of procedures, mechanical, electrical, computational, or other, whereby data are changed from one form into another.

data processor. A machine for handling information in a sequence of reasonable operations.

data reduction. Transformation of observed values into useful, ordered, or simplified information.

data smoothing. The mathematical process of fitting a smooth curve to dispersed data points.

datum. Any numerical or geometrical quantity or set of such quantities which can serve as a reference or a base for measurement of other quantities.

For a group of statistical references, the plural form is *data*; as *geographic data* for a list of latitudes and longitudes. Where the concept is geometrical the plural form is *datums*; as in *two geodetic datums have been used.*

datum line. Any line which can serve as a reference or **base** for the measurement of other quantities.

datum plane. A plane from which angular or linear measurements are reckoned. Also called *reference plane.*

datum point. Any point which can serve as a reference or **base** for the measurement of other quantities.

daughter, daughter element = **decay product.**

day. 1. The duration of one **rotation** of the earth, or another celestial body, on its axis.

A day is measured by successive transits of a reference point on the celestial sphere over the meridian, and each type takes its name from the reference used. Thus, for a *solar day* the reference is the sun; a mean solar day if the mean sun; and an *apparent solar day* if the apparent sun. For a *lunar day* the reference is the moon; for a *sidereal day* the vernal equinox; for a *constituent day* an astre fictif or fictitious star. The expression *lunar day* refers also to the duration of one rotation of the moon with respect to the sun. A *Julian day* is the consecutive number of each day, beginning with January 1, 4317 BC.

2. A period of 24 hours beginning at a specified time, as the civil day beginning at midnight, or the astronomical day beginning at noon.

daylight saving time. See **time.**

daytime visual range = **visual range.**

D-display. In radar, a **C-display** in which the **blips** extend vertically to give a rough estimate of distance. Also called *D-indicator*, *D-scan*, *D-scope*.

dead band. An arrangement incorporated in a **guidance** system which prevents an error from being corrected until that error exceeds a specified magnitude.

dead reckoning (*abbr* **DR**). In navigation, determination of **position** by advancing a previous known position for **courses** and distances.

dead spot. In a **control** system, a region centered about the neutral control position where small movements of the actuator do not produce any response in the system.

dead time. In a radiation counter, the time interval, after the start of a count, during which the **counter** is insensitive to further **ionizing events.**

De Broglie wavelength. For a particle of mass m and velocity v, the De Broglie **wavelength,** $\lambda = h/mv$, where h is Planck constant.

debug. **1.** To isolate and remove malfunctions from a device, or mistakes from a **routine** or **program.** **2.** Specifically, in electronic manufacturing, to operate equipment under specified environmental and test conditions in order to eliminate early failures and to stabilize equipment prior to actual use. Also called *burn-in*.

Debye length. A theoretical length which describes the maximum separation at which a given **electron** will be influenced by the electric field of a given positive **ion.** Sometimes referred to as the *Debye shielding distance* or *plasma length.*

It is well known that charged particles interact through their own electric fields. In addition, Debye has shown that the attractive force between an electron and ion which would otherwise exist for very large separations is indeed cut off for a critical separation due to the presence of other positive and negative charges in between. This critical separation or Debye length decreases for increased plasma density.

Debye shielding distance = **Debye length.**

deca = **deka.**

decade. **1.** The interval between any two quantities having the ratio of 10:1. **2.** A group or series of 10.

decade counter. A **counter** that counts to 10 in one column of decimal notation; a **scale of 10 counter.**

decametric wave. See **frequency bands.**

decay. Decrease of a **radioactive** substance because of **nuclear** emission of alpha or beta particles, positrons, or gamma rays. See **radioactivity.**

In beta decay, for example, the emission of a β-particle, i.e., an electron, causes radioactive change into a daughter element of the same atomic weight as the parent element but of atomic number higher by 1.

decay constant. **1.** = **attenuation constant.** **2.** (*symbol* λ) A constant relating the instant rate of radioactive decay of a **radioactive** species to the number of atoms N present at a given time t. Thus,

$$-(\partial N/\partial t) = \lambda N$$

If N_0 is the number of atoms present at time zero then

$$N = N_0 e^{-\lambda t}$$

decay product. A **nuclide** resulting from the radioactive disintegration of a **radionuclide,** being formed either directly or as the result of successive transformations in a radioactive series. Also called *daughter*, *daughter element.*

A decay product may be either radioactive or stable.

decay time. **1.** In computer operations, the time required for a pulse to fall to one-tenth of its peak value. See **rise time.** **2.** In charge-storage **tubes,** the time interval during which the magnitude of the stored charge decreases to a stated fraction of its initial value.

The fraction is usually $1/e$ where e is the base of natural logarithms.

3. Approximately the lifetime of an orbiting object in a nonstable orbit.

Decay time is usually applied only to objects with short orbit lifetimes caused by atmospheric drag.

decayed object. An object once, but no longer, in orbit.

Decca. A long-range, ambiguous, two-dimensional navigation system using continuous-wave transmission to provide **hyperbolic lines of position** through the radio frequency phase comparison techniques from four transmitters.

Frequency band, 68 to 150 kilocycles.

decelerate. To cause to move slower; to decrease speed.

deceleration. The act or process of moving, or of causing to move, with decreasing speed. Sometimes called *negative acceleration.*

deceleration parachute. A parachute attached to a craft and deployed to slow the craft, especially during landing. Also called a *brake parachute*, *drogue parachute*, *parabrake.*

December solstice = **winter solstice.**

deci (*abbr* **d**). A prefix meaning multiplied by 10^{-1}; one-tenth.

decibel (*abbr* **db**). **1.** A dimensionless measure of the ratio of two **powers,** equal to 10 times the logarithm to the base 10 of the ratio of two powers P_1/P_2. **2.** One-tenth of a **bel.**

The power P_2 may be some reference power; in electricity, the reference power is sometimes taken as 1 milliwatt (*abbr* **dbm**); in acoustics, the decibel is often taken as 20 times the common logarithm of the sound pressure ratio, with the reference pressure as 0.0002 dyne per square centimeter.

decibel per second. A unit used to measure the **rate of decay** of a sound.

decimal coefficient of absorption. See **absorption coefficient.**

decimal digit. 1. One of the digits used in decimal notation, i.e., 1, 2, 3, 4, 5, 6, 7, 8, 9, or 0. **2.** One of 10 possible conditions.

decimal notation. A mathematical system in which each **digit** is the coefficient of some power of 10.

decimal point. The **base point** in decimal notation.

decimal-to-binary conversion. The mathematical process of converting a quantity from **decimal notation** to the equivalent **binary notation.** For example: 1 = 1; 7 = 111; 23 = 10111, etc. See **binary notation.**

decimetric wave. See **frequency bands.**

decimillimetric waves. See **frequency bands.**

decision element. In computer operations, any device which as the result of the **input** of data issues one of two or more possible **instructions.**

declination. 1. (*symbol* δ) Angular distance north or south of the **celestial equator;** the arc of an **hour circle** between the celestial equator and a point on the **celestial sphere,** measured northward or southward from the celestial equator through 90°, and labeled N or S to indicate the direction of measurement. **2.** (*symbol* $\boldsymbol{D}$) Magnetic declination. See **equatorial system.**

decoder. 1. A device for translating electrical **signals** into predetermined functions. **2.** In computer operations, a **network** or device in which one of two or more possible outputs results from a prescribed combination of inputs. Also called *many-to-few matrix.*

decommutator. Equipment for separation, **demodulation,** or demultiplexing commutated signals. See **commutator.**

decompression. The reduction of atmospheric pressure; particularly, various techniques for preventing **caisson disease.**

decompression sickness. A disorder experienced by deep sea divers and aviators caused by reduced atmospheric pressure and evolved gas bubbles in the body, marked by pain in the extremities, pain in the chest (chokes), occasionally leading to severe central nervous symptoms and neurocirculatory collapse. See **bends, dysbarism.**

decontamination. The act of removing chemical, biological, or **radiological** contamination from, or neutralizing it on, a person, item, or area.

decoupled. Of circuits or devices, interconnected through any means which passes only the static characteristics of a **signal.**

decrement. A decrease in the value of a variable. See **increment.**

decrement gage. A gage in which pressure is measured by the rate of decay in amplitude of the **oscillations** of an element suspended in the gas and set into motion by external controls. Also known as *decrement viscosity gage* or *viscosity manometer.*

Various types of decrement gage are distinguished according to the design of the oscillating element.

decrement viscosity gage = **decrement gage.**

definition. The clarity, fidelity, sharpness, resolution and brilliancy of an image, as a photographic image.

deflagration. A sudden or rapid burning, as opposed to a **detonation** or **explosion.**

deflecting force = **coriolis force.**

deflection-modulated indicator = **amplitude-modulated indicator.**

deflection of the vertical. The angular difference, at any place, between the direction of a plumb line (the **vertical**) and the perpendicular (the normal) to the **reference spheroid.** This difference seldom exceeds 30 seconds of arc. Also called *station error.*

When measured at the earth's surface the deflection of the vertical is equal to the angle between the **geoid** and the reference spheroid.

deflector. A plate, baffle, or the like that diverts something in its movement or flow, as: **(a)** a plate that projects into the airstream on the underside of an airfoil to divert the airflow, as into a slot—sometimes distinguished from a **spoiler; (b)** a conelike device placed or fastened beneath a rocket launched from the vertical position, to deflect the exhaust gases to the sides; **(c)** any of several different devices used on jet engines to reverse or divert the exhaust gases; **(d)** a **baffle** or the like to deflect and mingle fluids prior to combustion, as in certain jet engines.

degas. To remove gas from a material, usually

DEFRUIT - see FRUIT

by heating under **high vacuum.** Compare **get.**

degassing. The deliberate removal of gas from a material, usually by application of heat under **high vacuum.**

degauss. Slang for *demagnetize.*

degradation. Gradual deterioration in performance.

degree of freedom. 1. A mode of motion, either angular or linear, with respect to a **coordinate system,** independent of any other mode.

A body in motion has six possible degrees of freedom, three linear and three angular.

2. Specifically, of a gyro the number of **orthogonal axes** about which the spin axis is free to rotate. **3.** In an unconstrained dynamic or other system, the number of independent variables required to specify completely the state of the system at a given moment.

If the system has constraints, i.e., kinematic or geometric relations between the variables, each such relation reduces by one the number of degrees of freedom of the system. In a continuous medium with given boundary conditions, the number of degrees of freedom is the number of normal modes of **oscillation.**

4. Of a mechanical system, the minimum number of independent generalized **coordinates** required to define completely the positions of all parts of the system at any instant of time.

In general, the number of degrees of freedom equals the number of independent generalized displacements that are possible.

Deimos. A satellite of Mars orbiting at a mean distance of 23,500 kilometers.

deka (*abbr* **da**). A prefix meaning multiplied by 10. Sometimes spelled deca.

Del, Dlph. International Astronomical Union abbreviations for *Delphinus.* See **constellation.**

de Laval nozzle. [After Dr. Carl Gustaf Patrik de Laval (1845–1913), Swedish engineer.] A converging-diverging **nozzle** used in certain rockets. Also called *Laval nozzle.*

delay. The time (or equivalent distance) displacement of some characteristic of a **wave** relative to the same characteristic of a reference wave; that is, the difference in **phase** between the two waves. Compare **lag.**

In one-way radio propagation, for instance, the phase delay of the reflected wave over the direct wave is a measure of the extra distance traveled by the reflected wave in reaching the same receiver.

delayed neutrons. Neutrons emitted by excited nuclei in a radioactive process, so called because they are emitted an appreciable time after the **fission.** Compare **prompt neutrons.**

delayed plan position indicator. See **plan position indicator.**

delay element. A device for causing time delay of a **signal.** See **delay line.**

delayer. A substance mixed in with **solid rocket** propellants to decrease the rate of combustion.

delay line. In electronic computers, any device for producing a time delay of a **signal.**

delay-line storage. A **storage** or memory device consisting of a **delay line** and means for regenerating and reinserting information into the delay line.

Dellinger effect = fadeout.

del-operator (*symbol* ∇). The operator used in vector calculus and defined in Cartesian coordinates as

$$\nabla = i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}$$

Delphinus (*abbr* **Del, Dlph**). See **constellation.**

delta ray. 1. An **electron** ejected by recoil when a rapidly moving **alpha particle** or other charged particle passes through matter. **2.** By extension any secondary ionizing **particle** ejected by recoil when a primary particle passes through matter.

delta wing. A triangularly shaped wing of an aircraft.

deluge collection pond. A facility at a **launch site** into which water used to cool the **flame deflector** is flushed as the **rocket** begins its ascent. Also called a *skimmer basin.*

demand oxygen system = demand system.

demand system. An **oxygen system** in which oxygen flows to the user during inspiration only.

demodulation. The process of recovering the **modulating wave** from a modulated carrier.

demodulator. An electronic device which operates on an input of a modulated **carrier** to recover the **modulating wave** as an output.

denitrogenation. The removal of nitrogen dissolved in the blood and body tissues, usually by breathing of pure oxygen for an extended period of time in order to prevent **aeroembolism** at high altitudes.

densitometer. An instrument for the measurement of **optical density** (photographic transmission, photographic reflection, visual transmission, etc.) of a material, generally of a photographic image.

density function. The number of particles per unit volume. See **distribution function.**

density specific impulse. The product of the

specific impulse of a **propellant** combination and the average **specific gravity** of the propellants.

departure = **deviation,** sense 1.

dependent variable. Any **variable** considered as a function of other variables, the latter being called *independent.* Compare **parameter.**

Whether a given quantity is best treated as a dependent or independent variable depends upon the particular problem.

depletion layer. In a semiconductor, a region in which the mobile carrier charge density is insufficient to neutralize the net fixed charge density of **donors** and **acceptors.** Also called *barrier.*

deploy. Of a parachute, to release so as to let it fill out or to unfold and fill out.

depressed pole. The **celestial pole** below the horizon, of opposite name to the **latitude.**

The celestial pole above the horizon is called the *elevated pole.*

depression angle = **angle of depression.**

depth perception. The ability to estimate depth or distance between points in the field of vision.

derivative data. Data which have been derived from other data by mathematical techniques.

descending node. That point at which a planet, planetoid, or comet crosses to the south side of the **ecliptic;** that point at which a **satellite** crosses to the south side of the equatorial plane of its primary. Also called *southbound node.* The opposite is *ascending node* or *northbound node.*

design gross weight. The **gross weight** at take-off that an aircraft, rocket, etc., is expected to have, used in design calculations.

desorption. The process of removing **sorbed** gas.

destruct. The deliberate action of destroying a **rocket** vehicle after it has been launched, but before it has completed its course.

Destructs are executed when the rocket gets off its plotted course or functions in a way so as to become a hazard.

destruct line. On a rocket test range, a boundary line on each side of the downrange course beyond which a rocket cannot fly without being destroyed under destruct procedures, or a line beyond which the **impact point** cannot pass. See **command destruct.**

detached shock = **detached shock wave.**

detached shock wave. A **shock wave** not in contact with the body which originates it. See **bow wave.** Also called *detached shock.*

detachment. A particular state of isolation in which man is separated or detached from his accustomed behavioral **environment** by inordinate physical and psychological distances. This condition may compromise his performance.

detection. See **recognition,** note.

detector. 1. = **sensor,** sense **1. 2.** An instrument employing a sensor, sense **1**, to detect the presence of something in the surrounding environment.

detonation. A rapid chemical reaction which propagates at a **supersonic** velocity.

detonation wave. A **shock wave** in a combustible mixture, which originates as a **combustion wave.**

deuterium. (*symbol* **D, d**) A heavy isotope of hydrogen having one proton and one neutron in the nucleus.

The symbol D is often used to designate deuterium in compounds, as HDO for molecules of that composition. Official chemical nomenclature uses the designation d with a number which designates the carbon atom to which the deuterium is bound; e.g., 2–d propane designates CH_3CHDCH_3.

deuteron. The **nucleus** of a **deuterium** atom.

deviation. 1. In statistics, the difference between two numbers. Also called *departure.*

It is commonly applied to the difference of a variable from its mean, or to the difference of an observed value from a theoretical value.

2. = **magnetic deviation. 3.** In radio transmission, the apparent variation of frequency above and below the unmodulated or center frequency.

dewpoint. The **temperature** to which a given parcel of air must be cooled at constant pressure and constant water-vapor content in order for saturation to occur; the temperature at which the saturation **vapor pressure** of the parcel is equal to the actual vapor pressure of the contained water vapor. Any further cooling usually results in the formation of dew or frost. Also called *dewpoint temperature.*

When this temperature is below 0° C, it is sometimes called the *frost point.*

dewpoint temperature = **dewpoint.**

DF (*abbr*) = ***d**irection **f**inder.* See **radio direction finder.**

diabatic process. A process in a **thermodynamic** system in which there is a transfer of heat across the boundaries of the **system.**

Diabatic process is preferred to *nonadiabatic process.*

diamonds. The pattern of **shock waves** often visible in a **rocket** exhaust which resembles a series of diamond shapes placed end to end.

diaphragm manometer. A **displacement manometer** employing a flexible diaphragm as the movable partition.

diastolic blood pressure. The pressure exerted by the blood during periods between cardiac contraction.

dichotomy. In astronomy, a **configuration** of three bodies so that they form a right triangle; specifically, such a configuration in the **solar system** with the sun at the apex of the 90° angle.

dielectric. A substance that contains few or no free charges and which can support electrostatic stresses.

In an electromagnetic field, the centers of the nonpolar molecules of a dielectric are displaced, and the polar molecules become oriented close to the field. The net effect is the appearance of charges at the boundaries of the dielectric. The frictional work done in orientation absorbs energy from the field which appears as heat. When the field is removed the orientation is lost by thermal agitation and so the energy is not regained. If free-charge carriers are present they too can absorb energy.

A good dielectric is one in which the absorption is a minimum. A vacuum is the only perfect dielectric. The quality of an imperfect dielectric is its *dielectric strength;* and the accumulation of charges within an imperfect dielectric is termed *dielectric absorption.*

dielectric absorption. See **dielectric.**

dielectric constant (*symbol* ϵ). For a given substance, the ratio of the capacity of a condenser with that substance as dielectric to the capacity of the same condenser with a vacuum for dielectric. It is a measure, therefore, of the amount of electrical charge a given substance can withstand at a given **electric field strength;** it should not be confused with **dielectric strength.**

The dielectric constant ϵ is a function of temperature and frequency and is written as a complex quantity

$$\epsilon = \epsilon' - i\epsilon''$$

where ϵ' is the part that determines the displacement current and ϵ'' the dielectric absorption (see **dielectric**). For a nonabsorbing, nonmagnetic material ϵ' is equal to the square of the **index of refraction** and the relation holds only at the particular frequency where these conditions apply.

dielectric gradient. The spatial variation of the **dielectric constant** in a substance or medium.

This term is used frequently in reference to the propagation of radio energy. The magnitude of these gradients and the distance over which they occur, relative to the wavelength of the incident radiation, determine the extent to which targets will reflect radar energy. Sufficiently intense dielectric gradients (or index of refraction gradients) are believed to be the cause of certain echoes known as *angels.*

dielectric strength. A measure of the resistance of a **dielectric** to electrical breakdown under the influence of strong electric fields; usually expressed in volts per centimeter. Sometimes called *breakdown potential.*

difference of latitude. The shorter arc of any **meridian** between the **parallels** of two places, expressed in angular measure.

difference of longitude. The smaller angle at the **pole** or the shorter arc of a **parallel** between the **meridians** of two places, expressed in angular measure.

differential analyzer. An **analog computer** designed and used primarily for solving differential equations.

differential correction. In celestial mechanics, a method for finding from the observed residuals minus the computed residuals (O − C) small corrections which, when applied to the **orbital elements** or constants, will reduce the deviations from the observed motion to a minimum.

differential manometer. A **manometer** which indicates the pressure difference across two **ports.**

differential pressure. The pressure difference between two systems or volumes.

differential thermal analysis. The technique of detecting **endothermic** and **exothermic** phase changes and other processes within a heated material by the corresponding temperature changes.

differential transducer. A device which is capable of measuring simultaneously two separate stimulus sources and which provides an output proportional to the difference between the stimuli. See **transducer.**

differentiator. **1.** In computer operations, a device whose output is proportional to the derivative of an input signal. **2.** In electronics, a **transducer** whose output **waveform** is the time derivative of its input waveform.

diffracted wave. A **wave** whose front has been changed in direction by an obstacle or other nonhomogeneity in a medium, other than by **reflection** or **refraction.**

diffraction. The process by which the direction of **radiation** is changed so that it spreads into the geometric shadow region of an opaque or refractive object that lies in a radiation field.

Diffraction is an optical edge effect.

At present, reference to Huygen principle is a common means of explaining diffraction. Analysis of the interference between individual Huygen wavelets which originate in the vicinity of the edge of an irradiated body reveals that detectable amounts of radiant energy must invade the nominal shadow zone of the object, and there, by interference, set up characteristic energy distributions known as diffraction patterns. The amount of diffractive *bending* experienced by a ray is a function of wavelength; thus **dispersion** occurs, although dispersion is in the opposite sense to that produced by refraction.

diffraction propagation. Wave propagation around objects, or over the horizon, by **diffraction.**

Diffraction is due to the fact that from every point in a wave front a spherical front is generated which falls off in intensity away from the forward direction. A continuous series of such actions carries radiation around objects, or around the curvature of the earth, but with rapidly diminishing intensity.

diffuser. A specially designed **duct, chamber,** or section, sometimes equipped with guide vanes, that decreases the velocity of a fluid, as air, and increases its pressure, as in a jet engine, a wind tunnel, etc. See **supersonic diffuser.**

diffuse radiation. Radiant energy propagating in many different directions through a given small volume of space; to be contrasted with parallel radiation.

The ideal form of diffuse radiation is **isotropic radiation.** Careful distinction should be made between this concept and that of a **perfectly diffuse radiator.**

diffuse reflection. Any reflection process in which the reflected radiation is sent out in many directions usually bearing no simple relationship to the angle of incidence; the opposite of **specular reflection.** See **diffuse reflector, perfectly diffuse reflector.**

A term frequently applied to the process by which solar radiation is scattered by dust and other suspensoids in the atmosphere. See **diffuse sky radiation.**

diffuse reflector. Any surface which reflects incident rays in a multiplicity of directions, either because of irregularities in the surface or because the material is optically inhomogeneous, as a paint, although optically smooth; the opposite of a **specular reflector.** See **perfectly diffuse reflector.**

Ordinary writing papers are good examples of diffuse reflectors, whereas mirrors or highly polished metal plates are examples of specular reflectors. Almost all terrestrial surfaces (except calm water) act as diffuse reflectors of incident solar radiation.

diffuse skylight = diffuse sky radiation.

diffuse sky radiation. Solar radiation reaching the earth's surface after having been **scattered** from the direct solar beam by molecules or suspensoids in the atmosphere. Also called *skylight, diffuse skylight, sky radiation.*

Of the total light removed from the direct solar beam by scattering in the atmosphere (approximately 25 percent of the incident radiation), about two-thirds ultimately reaches the earth as diffuse sky radiation.

diffuse sound. Sound **energy** for which energy is uniform in the region considered and when all directions of energy **flux** at all parts of the region are equally probable.

diffusion. In an atmosphere, or in any gaseous system, the exchange of **fluid parcels** between regions, in apparently random motions of a scale too small to be treated by the **equations of motion. 2.** In materials, the movement of atoms of one material into the crystal lattice of an adjoining material, e.g., penetration of the atoms in a ceramic coating into the lattice of the protected metal. **3.** In ion engines, the migration of neutral atoms through a porous structure incident to ionization at the emitting surface.

diffusion coefficient. The absolute value of the ratio of the **molecular flux** per unit area to the concentration gradient of a gas diffusing through a gas or a porous medium where the molecular flux is evaluated across a surface perpendicular to the direction of the concentration gradient. See **diffusion, coefficient of mutual diffusion.**

diffusion equation. See **diffusivity.**

diffusion velocity. 1. The relative mean molecular velocity of a selected gas undergoing **diffusion** in a gaseous atmosphere, commonly taken as a nitrogen (N_2) atmosphere.

The diffusion velocity is a molecular phenomenon and depends upon the gaseous concentration as well as upon the pressure and temperature gradients present.

2. The velocity or speed with which a turbulent diffusion process proceeds as evidenced by the motion of individual **eddies.**

diffusive equilibrium. The **steady state** resulting from the **diffusion** process, primarily of interest when external forces or sources and sinks exist within the field. See **isothermal equilibrium.**

diffusivity. A measure of the rate of **diffusion** of a substance, expressed as the diffusivity coefficient K. When K is constant, the diffusion equation is

$$\frac{\partial q}{\partial t} = K\nabla^2 q$$

where q is the substance diffused; ∇^2 is the Laplacian operator; and t is time. The diffusivity has dimensions of a length times a velocity; it varies with the property diffused, and for any given property it may be considered a constant or a function of temperature, space, etc., depending on the context. Also called *coefficient of diffusion.* See **conductivity, kinematic viscosity, exchange coefficients.**

In the case of molecular diffusion the length dimension is the **mean free path** of the molecules. By analogy, in eddy diffusion, length becomes the **mixing length.** The coefficient is then called the *eddy diffusivity*, and is in general several orders of magnitude larger than the molecular diffusivity.

difluence. The **divergence** vector of adjacent **streamlines.** The opposite of **confluence.**

digit. **1.** A single symbol or **character** representing an integral quantity. **2.** Any one of the symbols used in **positional notation** as coefficients of each power, or order, of the base. See **binary digit, decimal digit.**

digital. Using **discrete** expressions to represent **variables.**

digital computer. A **computer** which operates with information, numerical or otherwise, represented in a **digital** form.

digital output. **Transducer** output that represents the magnitude of the stimulus in the form of a series of discrete quantities coded to represent **digits** in a system of notation. Compare **analog output.**

digitize. To express an **analog** measurement of a variable in **discrete** units.

digitizer. A device which converts **analog** data into numbers expressed in **digits** in a system of notation. Also called *analog-to-digital converter.*

dihedral angle. The acute angle between two intersecting planes or between lines representative of planes.

D-indicator = **D-display.**

Dione. A satellite of Saturn orbiting at a mean distance of 378,000 kilometers.

dioptric light. A light concentrated into a collimated beam by means of **refracting** lenses or prisms.

One collimated by means of a reflector is a catoptric light.

dip. **1.** = **dip angle.** **2.** = **magnetic dip.**

dip angle (*symbol* δ). The vertical angle between the true horizon and the apparent horizon.

dip equator = **aclinic line.**

diplexer. A device permitting an **antenna** system to be used simultaneously or separately by two transmitters. Compare **duplexer.**

diplex transmission. The simultaneous transmission of two signals using a common **carrier wave.** Compare **duplex operation, multiplexing.**

dipole. **1.** A system composed of two, separated, equal electric or magnetic charges of opposite sign. **2.** = **dipole antenna.**

dipole antenna. A straight **radiator,** usually fed in the center, and producing a maximum of radiation in the plane normal to its axis. The length specified is the overall length.

Common usage in **microwave** antennas considers a dipole to be a metal radiating structure which supports a line current distribution similar to that of a thin straight wire, a half **wavelength** long, so energized that the current has two nodes, one at each of the far ends.

dip pole = **magnetic pole.**

direct air cycle. A **thermodynamic** propulsion cycle involving a nuclear **reactor** and gas turbine or ramjet engine, in which air is the **working fluid.** Also called *direct cycle.*

Air is successively compressed in the compressor section, heated in the nuclear reactor, and expelled through the turbine-tailpipe section to obtain thrust.

direct-current discharge. The conduction of direct current through two **electrodes** immersed in a gas. See **Townsend discharge, glow discharge, arc discharge.**

direct cycle = **direct air cycle.**

directional antenna. An **antenna** that radiates or receives radio signals more efficiently in some directions than in others. See **Adcock antenna, loop antenna, sense antenna.**

A group of antennas arranged for this purpose is called an *antenna array.*

directional array = **antenna array.**

directional emittance. **Emittance** in a stated direction from a surface. The direction is usually specified as angle from the normal.

directional gyro. **1.** A two-degree-of-freedom **gyro** with a provision for maintaining its spin axis approximately horizontal. **2.** A flight instrument incorporating a gyro that holds its position in **azimuth** and thus can be used as a directional reference.

directional properties. **1.** Of metals, properties whose magnitude varies depending on the relation of the test axis to a specific direction within the metal. The variation results from preferred orientation or from fibering of constituents or inclusions. **2.** For **thermal radiation** properties, in a specified direction from the surface, usually measured as the angle from the normal.

directional stability. The property of an aircraft, rocket, etc., enabling it to restore itself from a **yawing** or sideslipping condition. Also called *weathercock stability.*

direction angle. In tracking, the angle between the antenna **baseline** and an imaginary line connecting the center of the baseline with the target.

direction cosine. **1.** The cosine of the angle formed by the intersection of a line, as a line of sight to an orbiting body, with an axis of a rectangular coordinate system with the origin on the line.

Every line has three direction angles and three direction cosines: l, m, n corresponding to ψ, θ, ϕ, the direction angles with the x, y, and z axes.

2. Specifically, in **tracking,** the cosine of the angle between a **baseline** and the line con-

necting the center of the baseline with the target.

direction finder (*abbr* **DF**) = **radio direction finder.**

direction of relative movement. See **relative movement.**

directivity. The ability of an **antenna** to radiate or receive more energy in some directions than in others. See **beam.**

The directivity of an antenna implies a maximum value, and it is equal to the ratio of the maximum **field intensity** to the average field intensity at a given distance.

direct motion. Eastward or counterclockwise motion of a planet or other object as seen from the North Pole (motion in the direction of increasing **right ascension**).

direct product = **scalar product.**

directrix. An auxiliary line used in the geometrical construction of a **conic.**

direct solar radiation. In **actinometry,** that portion of the radiant energy received at the instrument direct from the sun, as distinguished from **diffuse sky radiation, effective terrestrial radiation,** or radiation from any other source. See **global radiation.**

Direct solar radiation is measured by **pyrheliometers.**

direct wave. A radio **wave** which travels directly from the transmitting antenna to the receiving antenna, in contrast with an indirect wave, which undergoes an abrupt change of direction by **refraction** or reflection.

discharge correction factor (*symbol* ζ_d). Of a rocket nozzle, the ratio of the **mass flow rate** in the nozzle to that of an **ideal nozzle** which expands an identical working fluid from the same initial conditions to the same exit pressure.

discharge tube. A form of **cold-cathode ionization gage** in which the color and form of a cold-cathode discharge, without the presence of a magnetic field, gives an indication of the pressure and the nature of the gas.

discone antenna. An **antenna** formed of a disk and a cone whose apex approaches and becomes common with the outer conductor of the coaxial feed at its extremity.

The center conductor terminates at the center of the disk which is perpendicular to the axis of the cone.

discontinuity. A break in sequence or continuity of anything.

discrete. Composed of distinct or discontinuous elements.

discrete radio source. A source of small angular extent of **cosmic radio waves.**

discrete spectrum. A **spectrum** in which the component wavelengths (and wave numbers and frequencies) constitute a **discrete** sequence of values (finite or infinite in number) rather than a **continuum** of values. See **continuous spectrum.**

discrete variable. A quantity that may assume any one of a number of individually distinct or separate values.

discriminator. In general, a **circuit** in which output depends upon the difference between an input signal and a reference signal.

dish. A **parabolic reflector** type of radio or radar **antenna.**

dislocation. In crystallography, a type of lattice imperfection whose existence in metals is postulated in order to account for the phenomenon of crystal growth and of slip, particularly for the low value of shear stress required to initiate **slip.**

One section of the crystal adjacent to the slip plane is assumed to contain one more atomic plane than the section on the opposite side of the slip plane. Motion of the dislocation results in displacement of one of the sections with respect to another.

dispersion. **1.** In rocketry, (a) deviation from a prescribed **flight path,** (b) specifically, **circular dispersion.** **2.** A measure of the scatter of data points around a mean value or around a regression curve.

Usually expressed as a standard-deviation estimate, or as a standard error of estimate. Note that the scatter is not centered around the true value unless systematic errors are zero.

3. The process in which **radiation** is separated into its component **wavelengths.**

Dispersion results when an optical process, such as **diffraction, refraction,** or **scattering,** varies according to wavelength.

4. In spectroscopy, a measure of the resolving power of a **spectroscope** or spectrograph, usually expressed in angstroms per millimeter. **5.** As applied to materials, a scattering of very fine particles (e.g., ceramics) within the body of a metallic material usually resulting in overall strengthening of the composite material.

dispersion equation = **frequency equation.**

dispersive medium. A medium in which the **phase velocity** of a wave, either **electromagnetic** or **hydromagnetic,** is a function of the **frequency.**

A **plasma** is a dispersive medium whereas **free space** is not, since waves of all frequencies travel in free space with the velocity of light.

displacement. A **vector quantity** that specifies the change of position of a body or particle usually measured from the **mean position** or position of rest.

Displacement can be represented by a rotation vector or translation vector, or both.

displacement manometer. A **differential manometer** which indicates the pressure difference, if any, across a solid or liquid partition which can be displaced against a restoring force.

display. The graphic presentation of the **output** data of any device or system.

dissociation. The separation of a complex **molecule** into constituents by **collision** with a second body, or by absorption of a photon.

The product of dissociation of a molecule is two **ions**, one positively charged and one negatively charged.

distance marker. A reference marker indicating distance, particularly such a marker on a radar indicator, to indicate distance of a target from the radar antenna. On a plan position indicator it is usually one of a series of concentric circles. Also called *range marker*. See **range ring.**

distance measuring equipment (*abbr* **DME**). A radio aid to navigation which provides distance information by measuring total round-trip time of transmission from an **interrogator** to a **transponder** and return.

distorted-angle fabric. Material of a special, often basketlike weave suitable for **pressure suits.** Such fabrics permit a certain amount of flexibility when the suit is pressurized.

distortion. 1. An undesired change in **waveform.**

Noise and certain desired changes in waveform, such as those resulting from modulation or detection, are not usually classed as distortion.

2. In a system used for transmission or reproduction of sound, a failure by the system to transmit or reproduce a received waveform with exactness. 3. An undesired change in the dimensions or shape of a structure as, *distortion of a fuel tank due to abnormal stresses or extreme temperature gradients.*

distribution function. The **density function** or number of particles per unit volume of **phase space.** The distribution function is a function of the three space coordinates and the three velocity coordinates.

A point in phase space represents a given position in ordinary space and a given velocity in **velocity space.** Therefore, the distribution function evaluated at such a point is the number or average density of particles per cubic length and cubic velocity that have the position and the velocity which is represented by the point. Distribution function represents the average density over a reasonably long time, or the most *probable* distribution of particles at a particular time.

diurnal. Having a period of, occurring in, or related to a **day.**

diurnal aberration. Aberration caused by the rotation of the earth. The value of diurnal aberration varies with the latitude of the observer and ranges from zero at the poles to 0.31 second of arc.

diurnal circle. The apparent daily path of a **celestial body,** approximating a **parallel of declination.**

diurnal motion. The apparent daily motion of a **celestial body** as observed from a rotating body.

divergence. 1. The expansion or spreading out of a **vector** field; also a precise measure thereof.

In mathematical discussion *divergence* is considered to include *convergence*, i.e., negative divergence.

2. A static instability of a lifting surface or of a body on a vehicle wherein the aerodynamic loads tending to deform the surface or body are greater than the elastic restoring forces.

divergence theorem. The statement that the volume integral of the divergence of a vector, such as the velocity U, over a volume V is equal to the surface integral of the normal component of U over the surface s of the volume, often called the *export* through the closed surface, provided that U and its derivatives are continuous and single-valued throughout V and s. This may be written

$$\iiint_V \nabla\cdot V\, dV = \oint\!\!\oint_s V\cdot \mathrm{n}\, ds$$

where n is a unit vector normal to the element of surface ds, and the symbol $\oint\!\!\oint$ indicates that the integration is to be carried out over a closed surface. This theorem is sometimes called *Green's theorem in the plane* for the case of two-dimensional flow, and *Green's theorem in space* for the three-dimensional case described above. Also called *Gauss theorem.*

The divergence theorem is used extensively in manipulating the meteorological equations of motion and aerodynamic equations of motion.

D-layer. See **ionosphere.**

DME (*abbr*) = **distance measuring equipment.**

Dobson spectrophotometer. A photoelectric **spectrophotometer** which is used in the determination of the ozone content of the atmosphere. The instrument compares the solar energy at two wavelengths in the **absorption band** of ozone by permitting the two radiations to fall alternately upon a photocell. The stronger radiation is then attenuated by an optical wedge until the photoelectric system of the photometer indicates equality of incident radiation. The ratio of radiation intensity is obtained by this process and the ozone content of the atmosphere is computed from the ratio.

docking. The act of coupling two or more orbiting objects; the operation of mechanically con-

necting together, or in some manner bringing together, orbital payloads.

doghouse. Slang for a protuberance or blister that houses an instrument or instruments on an otherwise smooth skin of a **rocket.**

dogleg. A directional turn made in the launch **trajectory** to produce a more favorable orbit **inclination,** as in *Echo I was launched on a dogleg to achieve an orbit inclined 47° to the equator.*

donor. In transistors, the N-type **semiconductor,** the electrode containing impurities which increase the number of available electrons. Contrast **acceptor.**

doping. Addition of impurities to a **semiconductor** or production of a deviation from **stoichiometric** composition to achieve a desired characteristic.

Doppler broadening. The broadening of either an **emission line** or an **absorption line** due to random motions of molecules of the gas that is emitting or absorbing the radiant energy. See **pressure broadening.**

In the case of an emitting gas, for example, those molecules which are approaching the observer as they emit quanta of radiant energy will, because of the Doppler effect, appear to send out a train of waves of slightly shorter wavelength than that characteristic of a stationary molecule, while receding molecules will appear to emit slightly longer wavelengths. The net effect, averaged over many molecules, is to superimpose, on the natural line width, a bell-shaped broadening that is proportional to the square root of the absolute temperature of the gas.

Doppler effect. The change in **frequency** with which energy reaches a receiver when the receiver and the energy source are in motion relative to each other. Also called *Doppler shift.*

In the case of sound, or any other wave motion where a real medium of propagation exists (excepting, therefore, light and other electromagnetic radiations) one must distinguish two principal cases: If the source is in motion with speed v relative to a medium which propagates the waves in question at speed c, then the resting observer receives waves emitted with actual frequency f as if they had a frequency f' given by the Doppler equation

$$f' = f/[1 \pm (v/c)]$$

where the positive sign refers to the case of the source receding from the observer, and vice versa for the negative sign. If, on the other hand, the source is at rest relative to the propagating medium while the observer moves with speed v relative to the source,

$$f' = f'[1 \pm (v/c)]$$

where the positive sign now refers to the case of observer approaching the source.

For electromagnetic radiation,

$$f/f' = [1 \mp (v/c)]/[1 \pm (v/c)]$$

where the top signs represent the source receding from the observer and the bottom signs, approaching the observer.

Doppler error. In using **Doppler radar,** the error in the measurement of target **radial velocities** due to atmospheric refraction. Compare **range error, azimuth error.**

These errors result from (a) the assumption of a constant wave velocity for a nonhomogeneous atmosphere and (b) the refraction or bending of the rays such that the ray path does not coincide with the geometrical straight line between the target and the radar. Errors due to (a) are of no practical importance, and, as in the case of elevation-angle error, the effects due to (b) are negligible except for elevation angles near the horizontal.

Doppler-Fizeau effect. The **Doppler effect** applied to a source of light. When the distance between the observer and the source of light is diminishing, the lines of the spectrum are displaced toward the violet, and, when the distance is increasing, they are displaced toward the red, the displacement being proportional to the relative velocity of approach or recession.

Doppler navigation. Dead reckoning performed automatically by a device which gives a continuous indication of position by integrating the speed derived from measurement of the **Doppler effect** of echoes from directed beams of radiant energy transmitted from the craft. See **Doppler radar.**

Doppler radar. A **radar** which detects and interprets the **Doppler effect** in terms of the **radial velocity** of a target.

Doppler ranging (*abbr* **Doran**). A continuous-wave **trajectory-measuring system** which utilizes the **Doppler effect** to measure the distances between a transmitter, a rocket transponder, and several receiving stations.

From these measurements trajectory data are computed. In contrast to less sophisticated systems, Doran obviates the necessity of continuously recording the Doppler signal by making simultaneous distance measurements with four different frequencies.

Doppler shift. 1. = **Doppler effect. 2.** The magnitude of the Doppler effect, measured in cycles per second.

Doppler system. In radar, any system utilizing the **Doppler effect** for obtaining information.

Doppler, velocity and position (*abbr* **Dovap**). A continuous-wave **trajectory-measuring system** using the **Doppler effect** caused by a target moving relative to a ground transmitter and receiving stations.

The transmitter interrogates a frequency doubling transponder and the output is received at three or more receiver sites for comparison with the interrogation frequency. The intersection of ellipsoids formed by the transmitter and each receiver site provides the spatial position of the target.

Dor, Dora. International Astronomical Union abbreviations for *Dorado.* See **constellation.**

Dorado (*abbr* **Dor, Dora**). See **constellation.**

Doran (*abbr*) = ***Doppler ranging.***

dorsal. Pertaining to the back.

dosimeter. **1.** An instrument for measuring the **ultraviolet** in solar and sky radiation. Compare **actinometer.** **2.** A device, worn by persons working around radioactive material, which indicates the *dose* of radiation to which they have been exposed.

dot product = **scalar product.**

double amplitude. In vibration terminology, the total, or peak-to-peak, dimensional displacement of a vibrating structure.

double-base propellant. A **solid rocket** propellant using two unstable compounds, such as nitrocellulose and nitroglycerin.

The unstable compounds used in a double-base propellant do not require a separate oxidizer.

double-dabble. A technique for binary to decimal conversion. Starting with the most significant **bit,** proceed, bit-by-bit, as follows: If the next bit is 0, double what you have (double); if the next bit is 1, double what you have and add 1 (dabble).

Thus, 111 (binary) = 7 (decimal)
10111 (binary) = 23 (decimal)

double-entry compressor. A **centrifugal compressor** that takes in air or fluid on both sides of the impeller, with vanes on each side to accelerate the fluid into the diffuser. The double-entry compressor is not a **multistage compressor.**

double-integrating gyro. A single-degree-of-freedom **gyro** having essentially no restraint of its spin axis about the output axis. In this gyro an **output** signal is produced by gimbal angular displacement, relative to the base, which is proportional to the double integral of the angular rate of the base about the input axis.

double local oscillator. An **oscillator** mixing system which generates two radio-frequency signals accurately spaced a few hundred cycles apart and mixes these signals to give the difference **frequency** which is used as the reference.

This equipment is used in an **interferometer** system to obtain a detectable signal containing the **phase** information of an antenna pair and the reference signal to allow removal of the phase data for use.

double precision. Of a computer, capable of processing twice as many columns as the number of **digits** in the quantities usually processed. See **precision.**

double sheath. See **plasma sheath.**

double stars. Stars which appear as single points of light to the eye but which can be resolved into two points by a telescope.

A *double star* is not necessarily a *binary*, a two-star system revolving about a common center, but may be an *optical double*, two unconnected stars in the same line of sight.

doublet. **1.** In fluid mechanics, a **source** and a **sink** of equal strength whose distance apart is zero. **2.** In spectroscopy, two lines resulting from **transitions** from the same state.

Dovap (*abbr*) = **Doppler, velocity and position.**

Dovap elsse. An **elsse** which utilizes the **Dovap** transponder as a signal source. Also called *beat-beat Dovap.*

down range. The airspace extending downstream on a given rocket test range.

downtime. A period during which equipment is not operating correctly because of machine failure.

DR (*abbr*) = **dead reckoning.**

Dra, Drac. International Astronomical Union abbreviations for *Draco.* See **constellation.**

Draco (*abbr* **Dra, Drac**). See **constellation.**

draconic month. The average period of **revolution** of the moon about the earth with respect to the moon's **ascending node,** a period of 27 days 5 hours 5 minutes 35.8 seconds, or approximately $27\frac{1}{4}$ days. Also called *nodical month.*

drag (*symbol* D). A retarding force acting upon a body in motion through a **fluid,** parallel to the direction of motion of the body. It is a component of the total fluid forces acting on the body. See **aerodynamic force.**

drag coefficient (*symbol* C_D). A coefficient representing the **drag** on a given airfoil or other body, or a coefficient representing a particular element of drag. See **Rayleigh formula.**

drag parachute. **1.** = **drogue parachute.** **2.** Any of various types of parachutes attached to high-performance aircraft that can be deployed, usually during landings, to decrease speed and also, under certain flight conditions, to control and stabilize the aircraft.

draperies (*abbr* **D.**). See **aurora.**

D-region. See **ionosphere.**

drift. **1.** The lateral divergence from the prescribed **flight path** of an aircraft, a rocket, or the like, due primarily to the effect of a crosswind. **2.** A slow movement in one direction of an instrument pointer or other marker. **3.** A slow change in **frequency** of a radio transmitter. **4.** The angular deviation of the spin axis of a **gyro** from a fixed reference in space. **5.** In semiconductors, the movement of **carriers** in an electric field.

drift mobility. In a semiconductor, the average drift velocity of **carriers** per unit electric field.

In general, the mobilities of holes and electrons are different.

drift rate. The amount of **drift,** in any of its several senses, per unit time.

Drift rate has many specific meanings in different fields. The type of drift rate should always be specified.

drift velocity. The average velocity of a charged **particle** in a **plasma** in response to an applied electric field.

The motion of an individual particle is quite erratic as it bounces off other particles and has its direction continually changed. On the average, however, a particle will slowly work its way in the direction of the applied electric force. This velocity is usually much smaller than the random velocity of the particle between collisions.

drogue. **1.** A device, usually shaped like a funnel or cone, dragged or towed behind something and used, e.g., as a sea anchor. **2.** A funnel-shaped part at the end of the hose of a tanker aircraft, used in air refueling to drag the hose out and stabilize it and to receive the probe of the receiving aircraft. **3.** = **drogue parachute.**

drogue parachute. **1.** A type of parachute attached to a body, used to slow it down; also called *deceleration parachute* or *drag parachute.* **2.** A parachute used specifically to pull something, usually a larger parachute, out of stowage, as, *a drogue parachute deploys a drag parachute.*

drogue recovery. A type of recovery system for space vehicles or space capsules after initial **reentry** into the atmosphere using deployment of one or more small parachutes to diminish speed, to reduce aerodynamic heating, and to stabilize the vehicle so that larger recovery parachutes can be safely deployed at lower altitudes without too great an opening shock.

drone. A remotely controlled **aircraft.**

dropout. Any **discrete** variation in signal level during the reproduction of recorded data which results in a data-reduction error.

dropsonde. A **radiosonde** equipped with a parachute, dropped from an aircraft to transmit measurements of atmospheric conditions as it descends.

dry adiabat. A line of constant **potential temperature** on a **thermodynamic diagram.** In terms of pressure p, and specific volume v, the equation for a dry adiabat may be written

$$pv^{c_p/c_v} = \text{Constant}$$

where c_p and c_v are the specific heats of dry air at constant pressure and volume, respectively.

Meteorologically, the dry adiabat is intended to represent the lifting of dry air in a dry-adiabatic process. Since this is also an isentropic process, a dry adiabat is an isentrope.

dry-adiabatic atmosphere = **adiabatic atmosphere.**

dry-adiabatic lapse rate. The rate of decrease of temperature with height of a parcel of dry air lifted adiabatically through the earth's atmosphere in hydrostatic equilibrium.

This lapse rate is g/c_p, where g is the acceleration of gravity and c_p is the specific heat of dry air at constant pressure; numerically equal to 9.767° C per kilometer or about 5.4° F per thousand feet.

Potential temperature is constant with height in an atmosphere with this lapse rate.

dry emplacement. A **launch emplacement** that has no provision for water cooling during launch. Compare **wet emplacement.**

dry friction damping = **coulomb damping.**

dry weight. The weight of a **rocket** vehicle without its fuel. Compare **take-off weight.**

This term, appropriate especially for **liquid rockets,** is sometimes considered to include the **payload.**

D-scan = **D-display.**

D-scope = **D-display.**

DSIF (*abbr*). ***D*eep *S*pace *I*nstrumentation *F*acility.** A worldwide network of tracking stations operated for the NASA by the Jet Propulsion Laboratory.

dual modulation. The process of modulating a single **carrier wave** or **subcarrier** by two different types of **modulation** (e.g., amplitude- and frequency-modulation) each conveying separate information.

dual thrust. A rocket **thrust** derived from two **propellant** grains using the same propulsion section of a missile.

The dual-thrust technique is considered to provide what is in effect a two-stage propulsion system without the disadvantages of jettisoning the booster unit and with the advantages of lower weight and shorter length.

dual-thrust motor. A **solid-propellant rocket engine** built to obtain **dual thrust.**

In a single chamber unit the booster propellant grain may be bonded to the sustainer grain, with the thrust level regulated by mechanically changing the nozzle throat area or by using different grain compositions or configurations. In a dual-chamber unit, the separate chambers may be arranged in tandem, or concentrically.

duct. Specifically, a tube or passage that confines and conducts a fluid, as a passage for the flow of air to the compressor of a gas-turbine engine, a pipe leading air to a supercharger, etc.

ducted fan. **1.** A **fan** enclosed in a **duct.** **2.** = **ducted-fan engine.**

ducted-fan engine. An aircraft engine incorporating a **fan** or propeller enclosed in a **duct;** especially, a **jet engine** in which an enclosed fan or propeller is used to ingest ambient air to augment the gases of combustion in the jetstream.

The air may be taken in at the front of the engine and passed around the combustion section, or it may be taken in aft of the combustion chamber. In the former case the ducted fan may be considered a type of bypass engine.

ducted rocket = **rocket ramjet.**

ducting. The trapping of an **electromagnetic wave,** in a **waveguide** action, between two layers of the **atmosphere,** or between a layer of the atmosphere and the earth's surface. See **refractivity, total refraction.**

Ducting is likely to occur where the gradient of the **index of refraction** exceeds 48 N-units per 1000 feet of altitude.

duct propulsion. A means of propelling a vehicle by ducting a surrounding **fluid** through an engine, adding **momentum** by mechanical or thermal means, and ejecting the fluid to obtain a reactive force. Compare **rocket propulsion.**

dummy. 1. In computer operations, an artificial and intrinsically useless unit of information inserted solely to fulfill certain prescribed conditions such as word length or block length. **2.** In rocketry, an inert **stage,** i.e., no propellant.

Dummy loads = used impedance & loading wattmeters & test search

dummy antenna. A device which has the necessary impedance characteristics of an **antenna** and the necessary power-handling capabilities, but which does not **radiate** or receive radio waves. Also called *artificial antenna.*

In receiver practice, that portion of the impedance not included in the signal generator is often called *dummy antenna.*

dump. In computer operations, **(a)** to destroy intentionally or accidentally stored information, **(b)** to transfer all or part of the contents of one section of **storage** into another section.

duplexer. A device which permits a single **antenna** system to be used for both transmitting and receiving.

Duplexer should not be confused with *diplexer*, a device permitting an antenna system to be used simultaneously or separately by two transmitters.

duplex operation. The operation of associated transmitting and receiving apparatus in which the processes of transmission and reception are concurrent. Compare **diplex transmission.**

dust. In meteor terminology, finely divided solid matter, with particle sizes in general smaller than micrometeorites, as *meteoric dust, meteoritic dust.*

duty factor. 1. In computer operations, the ratio of active time to total time. **2.** In a **pulse carrier** composed of pulses that recur at regular intervals, the product of the **pulse duration** and the pulse repetition **frequency.**

duty ratio. In a **pulse radar** or similar system the ratio of average to peak pulse power.

dye marker. A substance which, when placed in water, spreads out and colors the water immediately surrounding so as to make a spot readily visible from the air.

dynamical friction. 1. The drag force between electrons and ions drifting with respect to each other.

In a fully ionized **plasma**, collisions between electrons and ions are small angle **Coulomb collisions** and they produce a velocity-dependent drag force which is called *dynamical friction.*

2. Sliding friction, in contrast to **static friction.**

dynamical mean sun. A fictitious sun conceived to move eastward along the ecliptic at the average rate of the **apparent sun.** See **mean sun.**

The dynamical mean sun and the apparent sun occupy the same position in January, when the earth is **at perihelion.**

dynamic balance. The condition which exists in a rotating body when the axis about which it is forced to rotate, or to which reference is made, is parallel with a principal axis of inertia. No products of inertia about the center of gravity of the body exist in relation to the selected rotational axis.

Dynamic unbalance may be expressed in terms of slug-foot squared (or equivalent weight × length squared units) or in terms of inclination of the principal axis from the reference axis.

dynamic height. The height of a point in the **atmosphere** expressed in a unit proportional to the **geopotential** at that point. Since the geopotential at altitude z is numerically equal to the work done when a particle of unit mass is lifted from sea level up to this height, the dimensions of dynamic height are those of **potential energy** per unit mass. Also called *geodynamic height.*

The standard unit of dynamic height H_d is the dynamic meter (or geodynamic meter), defined as 10 meters per second squared; it is related to the geopotential φ, the geometric height z in meters, and the geopotential height Z in geopotential meters by

$$d\varphi = 10dH_d = 9.8dZ = gdz$$

where g is the acceleration of gravity in meters per second squared. (Some sources prefer to give the constants 10 and 9.8 the units of meters per second squared so that the units of φ and Z would be the same as those of the geometric height.) The dynamic meter is about 2 percent longer than the geometric meter and the geopotential meter. One of the practical advantages of the dynamic height over the geometric height is that when the former is introduced into the hydrostatic equation the variable acceleration of gravity is eliminated. In meteorological height calculations, **geopotential height** is more often used than dynamic height.

dynamic load. A load imposed by dynamic action, as distinguished from a static load. Specifically, with respect to aircraft, rockets, or spacecraft, a load due to an acceleration of craft, as imposed by gusts, by maneuvering, by landing, by firing rockets, etc.

dynamic meteorology. The study of atmospheric motions as solutions of the fundamental equations of hydrodynamics or other systems of equations appropriate to special situations.

dynamic meter. The unit of measurement of **dynamic height.** Also called *geodynamic meter.*

dynamic model. A model of an aircraft or other object having its linear dimensions and its weight and **moments of inertia** reproduced in scale in proportion to the original.

dynamic parallax. A value for the **parallax** of a **binary star** computed from the observations of the period and angular dimensions of the orbit by assuming a value for the mass of the binary system. Also called **hypothetical parallax.**

dynamic pressure (*symbol* q). The **pressure** of a fluid resulting from its motion, equal to one-half the fluid density times the fluid velocity squared $(1/2\rho V^2)$. In incompressible flow, dynamic pressure is the difference between **total pressure** and **static pressure.** Also called *kinetic pressure.* Compare **impact pressure.**

dynamic response = frequency response.

dynamic scale. The scale of the flow about a model relative to a flow about its prototype.

If two such flows have the same **Reynolds number**, both flows are said to be at the same dynamic scale.

dynamic similarity. The relationship existing between a model and its prototype when, by virtue of similarity between their geometric dimensions and mass distributions or elastic characteristics, the motion of the model in some respect (such as linear velocity, acceleration, vibration, flutter, etc.) is similar to the motion of the prototype; also, the similarity between the fluid flows about a scale model and its prototype when the flows have the same **Reynolds number.**

dynamic stability. The characteristics of a body, such as an aircraft or rocket, that causes it, when disturbed from an original state of steady flight or motion, to **damp** the oscillations set up by restoring moments and gradually return to its original state; specifically, the **aerodynamic characteristics.**

dynamic storage. In computer operations, information **storage** in which the information is continuously changing position, as, for example, *delay-line storage*, or *magnetic-drum storage.*

dynamic viscosity. Of a fluid, the ratio of the **shearing stress** to the **shear** of the motion. It is independent of the velocity distribution, the dimensions of the system, etc., and for a gas it is independent of pressure except at very low pressures. Also called *coefficient of molecular viscosity, coefficient of viscosity.*

For the dynamic viscosity μ of a perfect gas, the kinetic theory of gases gives

$$\mu = 1/3\ (\rho c\bar{l})$$

where ρ is the gas density, c is the average speed of the random heat motion of the gas molecules and is proportional to the square root of the temperature, and $\bar{l}$ is the mean free path. For dry air at 0° C, the dynamic viscosity is about 1.7×10^{-4} gram per centimeter per second.

Whereas the dynamic viscosity of most gases increases with increasing temperature, that of most liquids, including water, decreases rapidly with increasing temperature.

dynamometer. An instrument for measuring **power** or force; specifically, an instrument for measuring the power, torque, or **thrust** of an aircraft engine or rocket. See **thrust meter.**

dynamo theory. The hypothesis, first proposed by Balfour Stewart, which explains the regular daily variations in the earth's magnetic field in terms of electrical currents in the lower **ionosphere,** generated by tidal motions of ionized air across the earth's **magnetic field.**

dynamotor. A machine combining motor and generator action in a single **magnetic field,** either with two armatures or with one armature having two separate windings.

dyne. That unbalanced force which acting for 1 second on a body of 1 gram mass produces a velocity change of 1 centimeter per second.

The dyne is the unit of force in the CGS system.

dynode. In an electron tube, an **electrode** which performs a useful function by means of secondary **emission.**

dysbarism. A condition of the body resulting from the existence of a pressure differential between the total **ambient** pressure and the total pressure of dissolved and free gases within the body tissues, fluids, and cavities.

Characteristic symptoms, other than **hypoxia,** caused by decreased barometric pressure are **bends** and abdominal gas pains at altitudes above 25,000 to 30,000 feet. Increased barometric pressure, as in descent from high altitude, is characterized by painful distention of the ear drums.

dyspnea. Difficult or labored breathing.

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E

earphone. An **electroacoustic transducer** operating from an electrical system to an acoustical system and intended to be closely coupled acoustically to the ear.

earth. See **planet,** table.

earth axis. Any one of a set of mutually perpendicular reference **axes** established with the upright axis (the Z-axis) pointing to the center of the earth, used in describing the position or performance of an aircraft or other body in flight.

The earth axes may remain fixed or may move with the aircraft or other object.

earth current. A large-scale surge of electric charge within the earth's crust, associated with a disturbance of the **ionosphere.**

Current patterns of quasi-circular form and extending over areas the size of whole continents have been identified and are known to be closely related to solar-induced variations in the extreme upper atmosphere.

earthlight. The illumination of the dark part of the moon's disk produced by sunlight reflected onto the moon from the earth's surface and atmosphere. Also called *earthshine.*

Spectroscopic observations reveal that earthlight is relatively richer in blue light than is direct sunlight; this condition results from the fact that an appreciable part of the total earth reflection is backward-scattered light which, in accordance with **Rayleigh law,** is relatively rich in the blue and poor in the red.

earth point. The point where the forward straight-line projection of a **meteor** trajectory intersects the surface of the earth.

earth radiation = terrestrial radiation.

earth-rate unit (*abbr* **eru**). A unit of angular **drift,** as of a **gyro,** equal to the rate of angular movement of the earth with respect to the stars, 15° per hour.

earth satellite. A body that orbits about the earth; specifically, an artificial **satellite** placed in **orbit** by man.

earth shine = earthlight.

earth's rate correction. A command rate applied to a **gyro** to compensate for the apparent **precession** of the gyro spin axis with respect to its base caused by the rotation of the earth.

earth tide. A periodic movement of the earth's crust caused by the tide-producing forces of the moon and sun.

Ebert ion counter. An **ion counter** of the **aspiration condenser** type, used for the measurement of the concentration and mobility of **small ions** in the atmosphere.

ebullism. The formation of bubbles, with particular reference to water vapor bubbles in biological fluids caused by reduced ambient pressure; the boiling of body fluids.

eccentric. Not having the same center; varying from a circle.

eccentric anomaly (*symbol* ***E***). See **anomaly.**

eccentricity (*symbol* ***e***). **1.** Of any **conic,** the ratio of the length of the radius vector through a point on the conic to the distance of the point from the directrix. **2.** Of an **ellipse,** the ratio of the distance between the center and focus of an ellipse to its semimajor axis. Also called *numerical eccentricity.*

The eccentricity e of an ellipse can be computed by the formula

$$e = \sqrt{1 - b^2/a^2}$$

where a is semimajor axis and b is semiminor axis.

3. Of an ellipse, the distance between the center and the focus. Also called *linear eccentricity.*

echo. 1. A **wave** that has been reflected or otherwise returned with sufficient magnitude and delay to be detected as a wave distinct from that directly transmitted. **2.** In radar, a pulse of reflected radiofrequency energy; the appearance on a radar **indicator** of the energy returned from a target. Also called *blip.*

echo intensity. The brightness or brilliance of a radar **echo** as displayed on an **intensity-modulated indicator.** Echo intensity is, within certain limits, proportional to the voltage of the target signal or to the square root of its power. Compare **echo power.**

echo power. The electrical strength, or **power,** of a radar **target signal.** Echo power is normally measured in watts or dbm (decibels referred to a milliwatt).

echo pulse. A **pulse** of radio energy received at the radar after reflection from a target; that is, the **target signal** of a **pulse radar.**

echo signal = target signal.

eclipse. 1. The reduction in visibility or disappearance of a nonluminous body by passing into the shadow cast by another nonluminous body. **2.** The apparent cutting off, wholly or

partially, of the light from a luminous body by a dark body coming between it and the observer.

1. The first type of eclipse is exemplified by a lunar eclipse, the moon passing through the shadow cast by the earth; or by the passage of a **satellite** into the shadow cast by its planet; but when the satellite actually passes directly behind its planet, it may properly be termed an *occultation.*

2. The second type of eclipse is exemplified by a solar eclipse, caused by the moon passing between the sun and the earth. If the relative positions and distances are such that at a point on the earth the sun is completely obscured, the eclipse is *total;* if the distances are such that, when in line with the sun, the moon is surrounded by a ring of light, the eclipse is *annular;* and when the moon passes to one side of a straight line from sun to observer and shows a crescent of light, it is a *partial eclipse.*

eclipse year. The interval between two successive **conjunctions** of the sun with the same **node** of the moon's orbit, averaging 346 days 14 hours 52 minutes 52.42 seconds in 1962, and increasing at the rate of 0.0276 second annually. See **year.**

ecliptic. The apparent annual path of the sun among the stars; the intersection of the plane of the earth's **orbit** with the **celestial sphere.**

The ecliptic is a **great circle** of the celestial sphere inclined at an angle of about 23°27′ to the celestial equator.

ecliptic longitude = celestial longitude.

ecliptic pole. On the **celestial sphere,** either of the two points 90° from the **ecliptic.**

ecliptic system of coordinates. A set of **celestial coordinates** based on the **ecliptic** as the **primary great circle.** See **coordinate,** table.

The points 90° from the ecliptic are the north and south ecliptic poles. Angular distance north or south of the ecliptic, analagous to latitude, is celestial latitude. Celestial longitude is measured eastward along the ecliptic from the vernal equinox through 360°.

ecological system. A habitable **environment,** either created artifically, as in a manned space vehicle, or occurring naturally, such as the environment on the surface of the earth, in which man, animals, or other organisms can live in mutual relationship with one another and the environment.

Ideally the environment furnishes the sustenance for life, and the resulting waste products revert or cycle back into the environment to be used again for the continuous support of life.

ecology. The study of the environmental relations of organisms. See **environment.**

economizer. A reservoir in a **continuous-flow oxygen system** in which oxygen exhaled by the user is collected for recirculation in the system.

ecosphere. 1. = **biosphere.** 2. A volume of space surrounding the Sun, extending from the orbit of Venus past the orbit of Mars, in which some biologists believe conditions are favorable for the development and maintenance of life.

eddy. In a **fluid,** any circulation drawing its energy from a **flow** of much larger scale and brought about by pressure irregularities.

eddy coefficient = exchange coefficient.

eddy stresses = Reynolds stresses.

eddy velocity. The difference between the **mean velocity** of fluid **flow** and the instantaneous velocity at a point. For example,

$$u' = u - \bar{u},$$

where u' is the eddy velocity; u is instantaneous velocity; and $\bar{u}$ is mean velocity. Also called *fluctuation velocity.*

Over the same interval which defines the mean velocity, the average value of the eddy velocity is necessarily zero.

eddy viscosity. The turbulent transfer of **momentum** by **eddies** giving rise to an internal fluid friction, in a manner analogous to the action of **molecular viscosity** in laminar flow, but taking place on a much larger scale.

The value of the coefficient of eddy viscosity (an **exchange coefficient**) is of the order of 10^4 square centimeters per second, or 100,000 times the molecular kinematic viscosity.

edge effect. See **diffraction,** note.

E-display. In radar, a rectangular display in which **targets** appear as **blips** with distance indicated by the horizontal coordinate and **elevation** by the vertical coordinate. Also called *E-scan* and *E-scope.*

edit. In computer terminology, to arrange, delete, select, or add to information.

EDP (*abbr*) = **electronic data processing.**

education. Of a computer, stored **subroutines** and subprograms which are available for use in automatic programing.

effective aperture = effective area.

effective area. 1. In antenna design, the ratio of the **received power** available at the terminals of an **antenna** to the power per unit area in the incident wave. For all antennas, effective area A is related to gain G at a given wavelength λ by the equation:

$$A/G = \lambda^2/4\pi$$

Also called *effective aperture.* See **aperture.**

The effective area of an ideal antenna is equal to its physical area S. In practice, A/S for microwave antennas is always less than one, a representative value for paraboloids being 0.6.

2. Same as *scattering cross section.*

effective atmosphere. 1. That part of the **atmosphere** which effectively influences a

particular process or motion, its outer limits varying according to the terms of the process or motion considered.

For example, an earth satellite orbiting at 250 miles altitude remains within the ionosphere, but because the air particles are so sparse at this altitude as to cause no appreciable friction or deflection, the satellite may be considered to be outside the effective atmosphere. For movement of air vehicles the effective atmosphere ends at the **aeropause** (which see).

2. = **optically effective atmosphere.**

effective earth radius. See **effective radius of the earth.**

effective exhaust velocity. (*symbol* c_e). A fictitious **exhaust velocity** that would theoretically produce the observed value of **jet thrust.**

The effective exhaust velocity c_e is determined by the equation

$$c_e = V + [A(p_1 - p_2)g/\dot{w}]$$

where V is the velocity of the exhaust gases; A is the nozzle exit area; p_1 is static pressure at the nozzle exit; p_2 is ambient pressure; g is the acceleration of gravity; and $\dot{w}$ is the weight flow rate of exhaust gases.

effective multiplication factor (*symbol* k_e). The ratio of the **neutron flux** in a nuclear **reactor** to that supplied by a neutron source.

effective neutron cycle time. The lifetime of an average **neutron** within a **reactor** from the time it is produced to the time it is fission captured.

This average takes into account delayed as well as prompt neutrons.

effective propagation velocity. The velocity of an **electromagnetic** signal which, when multiplied by the transit time for a ray path, gives a value for actual path length.

effective radiation = **effective terrestrial radiation.**

effective radius of the earth. A fictitious value for the radius of the earth, used in place of the geometrical radius to correct for atmospheric refraction when the **index of refraction** in the atmosphere changes linearly with height. See **modified index of refraction.**

Under conditions of standard refraction the effective radius of the earth is 8.5×10^6 meters, or four-thirds the geometrical radius. If the effective radius is used in ray tracing diagrams, the rays may be drawn as though they were traveling in straight lines.

effective Reynolds number. A fictitious **Reynolds number** applied to the flow of air about a body in a **wind tunnel,** equal to the free-air Reynolds number at which the effect obtained is the same as the effect obtained in the wind tunnel.

effective sound pressure. The root-mean-square value of the instantaneous pressure of **sound waves,** taken over a complete cycle or a period long compared with a cycle, at that point. The unit is the microbar (dynes per square centimeter).

effective temperature. 1. In astrophysics, a measure of the temperature of a star deduced by means of the **Stefan-Boltzmann law,** from the total energy emitted per unit area. Compare **brightness temperature, color temperature.**

Effective temperature is always less than actual temperature.

2. In physiology, the temperature at which motionless, saturated air would induce, in a sedentary worker wearing ordinary indoor clothing, the same sensation of comfort as that induced by the actual conditions of temperature, humidity, and air movement. Compare **sensible temperature, standard operative temperature, operative temperature.**

Effective temperature is used as a guide in air-conditioning practice, and, on the comfort chart (American Society of Heating and Air Conditioning Engineers) it appears as a family of curves which serves as one coordinate in defining comfort zones.

effective terrestrial radiation. The amount by which outgoing infrared **terrestrial radiation** of the earth's surface exceeds downcoming infrared **counter-radiation** from the atmosphere. Also called *nocturnal radiation, effective radiation.* See **actinometer.**

It is to be emphasized that this amount is a positive quantity, of the order of several tenths of a langley per minute, at all times of day (except under conditions of low overcast clouds). It typically attains its diurnal maximum during the midday hours when high soil temperatures create high rates of outgoing terrestrial radiation. (For this reason the synonym *nocturnal radiation* is apt to lead to slight confusion.) However, in daylight hours the effective terrestrial radiation is generally much smaller than the **insolation,** while at night it typically dominates the energy budget of the earth's surface.

effective wavelength. The **wavelength** corresponding to the **effective propagation velocity.**

effector. Any device used to maneuver a **rocket** in flight, such as an aerodynamic surface, a gimbaled motor, or a jet.

efficiency (*symbol* η). Of a device with respect to a physical quantity which may be stored, transferred, or transformed by the device, the ratio of the useful output of the quantity to its total input.

Unless specifically stated otherwise, the term *efficiency* means efficiency with respect to **power.**

egads (*abbr*) = **electronic ground automatic destruct sequencer.**

egads button. A button used by the range safety officer to initiate destruction of a rocket vehicle in flight if its course, as plotted during flight, is predicted to go beyond the destruct

line. See **egads, impact predictor system.**

EHF (*abbr*) = ***E*xtremely *H*igh *F*requency.** See **frequency band.**

eigenmode = normal mode of vibration.

eigenvalue. See **characteristic-value problem.**

eight ball. Common name given to a flight **attitude indicator.**

ejection capsule. 1. In an aircraft or manned spacecraft, a detachable compartment serving as a cockpit or cabin, which may be ejected as a unit and parachuted to the ground. **2.** A satellite, probe, or unmanned spacecraft, a box-like unit, usually containing recording instruments or records of observed data, which may be ejected and returned to earth by a parachute or other deceleration device.

ejector. A device consisting of a **nozzle,** mixing tube, and **diffuser** utilizing the kinetic energy of a **fluid** stream to pump another fluid from a low pressure region by direct mixing and ejecting both streams.

Ekman layer. The layer of transition between the **surface boundary layer,** where shearing stress is constant, and the **free atmosphere,** where the atmosphere is treated as an ideal fluid in approximate **geostrophic** equilibrium. Also called *spiral layer.*

In Ekman's analysis (see **Ekman spiral**), the coefficient of eddy viscosity is assumed constant within this layer; subsequent calculations have relaxed this assumption.

Ekman spiral. As used in meteorology, an idealized mathematical description of the wind distribution in the **planetary boundary layer** of the atmosphere, within which the earth's surface has an appreciable effect on the air motion. The model is simplified by assuming that within this layer eddy viscosity and density are constant, the motion is horizontal and steady, the isobars are straight and parallel, and the **geostrophic wind** is constant with height.

elastic collision. A **collision** between two **particles** in which no change occurs in the internal energy of the particles, or in the sum of their kinetic energies. Commonly referred to as a *billiard-ball collision.*

elasticity. The ability of a body which has been deformed by an applied force to return to its original shape when the force is removed.

elasticizer. An elastic substance or fuel used in a solid rocket propellant to prevent cracking of the propellant **grain** and to bind it to the combustion-chamber case.

elastic wave. See **sound.**

elastomers. Rubber-like compounds.

Elastomers are used as pliable components, as in tires, seals, or gaskets.

E-layer. A division of the **ionosphere,** usually found at an altitude between 100 and 120 kilometers in the **E-region.** It exhibits one or more distinct maximums and sharp gradients of **free electron** density. It is most pronounced in the daytime but does not entirely disappear at night. Also called *E_1-layer, Kennelly-Heaviside layer, Heaviside layer.* See **sporadic E-layer, atmospheric shell, ionosphere.**

There is some evidence to indicate a second layer above the normal E-layer located at about 150 kilometers, and called the *E_2-layer.*

electrical. Involving the flow of electricity in a conductor. Compare **electronic.**

electrical distance. The distance between two points expressed in terms of the duration of travel of an **electromagnetic wave** in free space between the two points.

A convenient unit of electrical distance is the light microsecond or approximately 983 feet (300 meters). In the use of this unit, electrical distance is numerically equal to transmission time in microseconds.

electrical element. See **element,** sense **2.**

electrical engine. A **rocket engine** in which the **propellant** is accelerated by some electrical device. Also called *electric propulsion system, electric rocket.*

Electrical engines can be classified as electrothermal, electrostatic, or electromagnetic, depending on the nature of the accelerating device.

electric-current element = electric dipole.

electric dipole. A pair of equal and opposite charges an infinitesimal distance apart.

In electromagnetics, the term *dipole* is often applied to two equal and opposite oscillating charges an infinitesimal distance apart; in this sense, it is synonymous with an *electric-current element.*

electric discharge. The flow of electricity through a gas, resulting in the **emission** of radiation that is characteristic of the gas and of the intensity of the current. Also called *discharge, gaseous electric discharge, gaseous discharge.* See **corona discharge, point discharge, spark discharge, lightning discharge.**

electric field. 1. A region in which a charged particle would experience an electrical force; the geometric array of the imaginary **electric lines of force** that exist in relation to points of opposite charge.

An electric field is a vector field in which magnitude of the vector is the electric-field strength and the vector is parallel to the lines of force.

2. = electric-field strength. See **atmospheric electric field.**

electric-field intensity = **electric-field strength.**

electric-field strength. The electrical force exerted on a unit positive charge at a given point in space. Electric-field strength is expressed, in the practical system of electrical units, in terms of volts/centimeter. It is a vector quantity, being the magnitude of the electric-field vector. Also called *electric field, electric intensity, electric field intensity, electric potential gradient, field strength.*

The electric-field strength of the atmosphere is commonly referred to as the *atmospheric electric field.*

electric intensity = **electric-field strength.**

electric lines of force. Imaginary lines defined by the paths traced by unit charges placed in an electric field. Lines of force are everywhere parallel to the **electric field strength** vector. Their principal use is as a convenient means of picturing the geometry of an electric field. See **magnetic lines of force.**

electric potential. In electrostatics, the work done in moving unit positive charge from infinity to the point whose potential is being specified. Sometimes shortened to *potential.*

electric potential gradient = **electric-field strength.**

electric power level = **level.**

electric propulsion. A general term encompassing all the various types of propulsion in which the **propellant** consists of charged electrical particles which are accelerated by electrical or magnetic fields, or both; for example, electrostatic propulsion, electromagnetic propulsion, electrothermal propulsion.

electroacoustic transducer. A **transducer** for receiving **waves** from an electric system and delivering waves to an **acoustic** system, or vice versa.

Microphones and earphones are electroacoustic transducers.

electrochemical. See **chemical energy.**

electrochemical transducer. A **transducer** which uses a chemical change to indicate the input parameter.

electrode. **1.** A terminal at which electricity passes from one medium into another. The positive electrode is called *anode;* the negative electrode is called *cathode.* **2.** In a semiconductor device, an **element** that performs one or more of the functions of emitting or collecting **electrons or holes,** or of controlling their movements by an electric field. **3.** In electron tubes, a conducting **element** that performs one or more of the functions of emitting, collecting or controlling, by an electromagnetic field, the movements of electrons or ions. See **anode** (electron tubes) and **cathode.**

electrodynamics. The science dealing with the forces and energy transformations of electric currents, and the **magnetic fields** associated with them.

electrojet. A laterally limited relatively intense electric current located in the **ionosphere.**

electrokinetic transducer. A **transducer** that depends for its operation on the dielectric polarization in certain liquids resulting from viscous shearing stress that accompanies flow through porous materials.

electroluminescence. **Emission** of light caused by an application of electric fields to solids or gases.

In gas electroluminescence, light is emitted when the kinetic energy of electron or ions accelerated in an electric field is transferred to the atoms or molecules of the gas in which the discharge takes place.

electromagnetic. Of or pertaining to magnetism produced by or associated with electricity.

Magnetoelectric pertains to electricity produced by or associated with magnetism.

electromagnetic energy = **electromagnetic radiation.**

electromagnetic radiation. Energy propagated through space or through material media in the form of an advancing disturbance in electric and magnetic fields existing in space or in the media. The term *radiation,* alone, is used commonly for this type of energy, although it actually has a broader meaning. Also called *electromagnetic energy* or simply *radiation.* See **electromagnetic spectrum.**

electromagnetic rockets = **plasma rockets.** See **electric propulsion.**

electromagnetic spectrum. The ordered array of known **electromagnetic radiations,** extending from the shortest cosmic rays, through gamma rays, X-rays, ultraviolet radiation, visible radiation, infrared radiation, and including microwave and all other wavelengths of radio energy. See **absorption spectrum.**

The division of this continuum of wavelengths (or frequencies) into a number of named subportions is rather arbitrary and, with one or two exceptions, the boundaries of the several subportions are only vaguely defined. Nevertheless, to each of the commonly identified subportions there correspond characteristic types of physical systems capable of emitting radiation of those wavelengths. Thus, gamma rays are emitted from the nuclei of atoms as they undergo any of several types of nuclear rearrangements; visible light is emitted, for the most part, by atoms whose planetary electrons are undergoing transitions to lower energy states; infrared radiations are associated with characteristic molecular vibrations and rotations; and radio waves, broadly speaking, are emitted by virtue of the accelerations of

free electrons as, for example, the moving electrons in a radio antenna wire.

electromagnetic theory. See **electromagnetic radiation.**

electromagnetic wave. A wave produced by **oscillation** of an electric charge. See **electromagnetic radiation.**

electromagnetism. **1.** Magnetism produced by an electric current. **2.** The science dealing with the physical relations between electricity and magnetism.

electromechanical transducer. A **transducer** for receiving **waves** from an electric system and delivering waves to a mechanical system, or vice versa.

electrometeor. A visible or audible manifestation of **atmospheric electricity.** This includes, therefore, not only visible electric discharges (igneous meteors) but also the sounds produced by them, principally thunder.

electrometer. An instrument for measuring differences of **electric potential.**

electromyogram. A record of the response of a muscle to an electric stimulation.

electron. The **subatomic particle** that possesses the smallest possible negative electric charge (4.80298×10^{-10} electrostatic units). See **physical constants,** tables.

The mass of the electron is approximately equal to 1/1836 that of a hydrogen atom; its theoretical **rest mass** (*symbol* m_e) is equal to $(9.1091) \times 10^{-28}$ grams and its rest energy is equal to 0.511006 million electron-volt. The charge-to-mass ratio for the electron (*symbol* e/m_e) is 1.758796 $cc^{1/2}/g^{1/2}$.

The term *electron* is usually reserved for the orbital or extranuclear particle, whereas the term *beta particle* refers to a nuclear electron.

electron avalanche. The process in which a relatively small number of free **electrons** in a gas that is subjected to a strong electric field accelerate, ionize gas atoms by collison, and thus form new free electrons to undergo the same process in cumulative fashion.

An avalanche cannot begin until the local electric field strength is high enough to accelerate a free electron to the **minimum ionizing speed** in the space and time interval corresponding to one mean free path of the electron, for upon collision, the electron usually loses its forward motion in the direction of the field.

electron beam. Specifically, a focused stream of **electrons** used for neutralization of the positively charged ion beam in an **ion engine.** Also used to melt or weld materials with externally high melting points.

electron device. A device in which electricity is conducted principally by **electrons** moving through a vacuum, gas, or semiconductor.

electron gun. An **electrode** structure which produces and may control, focus, deflect, and converge one or more **electron beams.**

electronic. **1.** Involving the flow of **electrons** in a vacuum or through **semiconductors.** **2.** Of or pertaining to electronics, **i.e.,** to that branch of physics that treats of the emission, transmission, behavior, and effects of electrons, especially as applied by means of vacuum tubes, cathode-ray tubes, photoelectric cells, and the like, together with the associated electrical devices.

electronic Bohr magneton = Bohr magneton.

electronic data processing. The use of **electronic** devices and systems in the processing of data so as to interpret the data and put them into usable form.

electronic missile acquisition (*abbr* **EMA**). A crossed baseline **interferometer** system giving **azimuth** and **elevation** angles.

This system was designed as an acquisition aid for theodolites. The EMA equipment operates on the **Dovap** transponder frequency.

electronics. That branch of physics that treats of the emission, transmission, behavior, and effects of **electrons.** See **electronic.**

electronic sky screen equipment. See **elsse.**

electronic transducer. A **unilateral transducer** that depends for its operation on the generation of a voltage by the relative motion of the **electrodes** in a vacuum tube.

electronic work function = Helmholtz function.

electron tube. A device in which conduction by **electrons** takes place through a vacuum or gaseous medium within a gastight envelope.

electron-volt (*abbr* **ev**). A unit of **energy** equal to the energy required to move an electron through a potential difference of 1 volt. Often shortened to *volt.*

One electron volt equals 1.6020×10^{-9} joule.

electrostatic memory. The ability of a substance or device to retain an **electrostatic** charge after the charging force is removed.

electrostatic rocket = ion rocket. See **electric propulsion, ion engine.**

electrostatic storage. In a computer, **storage** of information in the form of **electrostatic** charges.

electrostatic-storage tube. A **cathode-ray tube** in which information is stored as positive or negative charges on a **dielectric** surface.

electrostriction. The phenomenon wherein some **dielectric** materials experience an elastic strain when subjected to an electric field, this strain being independent of polarity of the field.

electrothermal rocket = **electric thermal rocket.** See **electric propulsion.**

element. **1.** One of the simple parts of which a complex entity is composed. **2.** In chemistry, a substance which cannot be broken down by ordinary chemical means into simpler components. **3.** In an **electron tube,** a constituent part of the tube that contributes directly to the electrical operation of the tube. **4.** In a **circuit,** any electrical device (such as inductor, resistor, capacitor, generator, line, electron tube) with terminals at which it may be directly connected to other electrical devices. **5.** In a **semiconductor device,** any integral part of the semiconductor device that contributes to its operation. **6.** = **orbital element.**

elevated pole. The **celestial pole** above the **horizon.**

The celestial pole below the horizon is called *depressed pole.*

elevation = **angle of elevation.**

elevation angle = **angle of elevation.**

ELF (*abbr*) = ***e**xtremely **l**ow **f**requency.* See **frequency band.**

ellipse. A plane curve constituting the locus of all points the sum of whose distances from two fixed points called *focuses* or *foci* is constant; an elongated circle. See **conic section.**

The **orbits** of planets, satellites, planetoids, and comets are ellipses, the primary being at one focus.

ellipsoid. A surface whose plane sections (cross sections) are all **ellipses** or circles, or the solid enclosed by such a surface. Also called *ellipsoid of revolution, spheroid.*

ellipsoid of revolution = **ellipsoid.**

It is so named from the fact that it can be formed by revolving an **ellipse** about one of its axes.

elliptic. Pertaining to an **ellipse,** or in the form of an ellipse.

elliptically polarized sound wave. A **transverse wave** in an elastic medium in which the displacement vector at any point rotates about the point and has a magnitude which varies as the **radius vector** of an **ellipse.**

An elliptically polarized wave is equivalent to two superposed plane polarized waves of simple sinusoidal form in which the displacements lie in perpendicular planes and are 90° apart in phase.

elliptical polarization. The **polarization** of a **wave** radiated by an electric vector rotating in a plane and simultaneously varying in amplitude so as to describe an ellipse.

elliptical system. A tracking or navigation system where **ellipsoids** of position are determined from time or **phase** summation relative to two or more fixed stations which are the focuses for the ellipsoids.

ellipticity (*symbol* ***e***). The amount by which a **spheroid** differs from a sphere or an **ellipse** differs from a circle, calculated by dividing the difference in the length of the axes by the length of the major axis. Also called *compression.* See **flattening.**

ellipticity ratio. **1.** The ratio of the **major axis** to the **minor axis** of an **ellipse.**
2. As a measure of **elliptical polarization,** the power ratio of the maximum to the minimum electric vectors of an elliptically polarized antenna.

elongation. The angular distance of a body of the **solar system** from the sun; the angle at the earth between lines to the sun and another celestial body of the solar system. The term is usually used only in connection with **inferior planets.**

The greatest elongation of such a body is its maximum angular distance from the sun before it starts back toward conjunction. The direction of the body east or west of the sun is usually specified, as *greatest elongation east.*

elsse (*abbr*) = ***E**lectronic **s**ky **s**creen **e**quipment.* An **electronic device** which indicates the departure of a rocket from a predetermined **trajectory.**

EMA (*abbr*) = ***e**lectronic **m**issile **a**cquisition.*

embolism. Large amounts of air in the blood stream which, reaching the heart, cause it to fail; small amounts are resorbed and cause no symptoms.

emissance = **emittance,** sense **2.**

emission. **1.** With respect to **electromagnetic radiation,** the process by which a body emits electromagnetic radiation as a consequence of its temperature only. Compare **reflection, transmission.** See **emittance, emissivity.**
2. With respect to **electric propulsion** and energy conversion, the sending out of charged particles from a surface causing the generation of these particles; e.g., emission of ions from an ionizing surface in ion engines.

emission line. A minute range of **wavelength** (or **frequency**) in the **electromagnetic spectrum** within which radiant energy is being emitted by a radiating substance. See **spectral line, emission spectrum.**

emission spectrum. The array of **wavelengths** and relative intensities of **electromagnetic radiation** emitted by a given radiator.

Each radiating substance has a unique, characteristic emission spectrum, just as every medium of transmission has its individual **absorption spectrum.**

emissive power. The rate of thermal **emission** of **radiant energy** per unit area of emitting

surface. Usually called **thermal emissive power.**

emissivity (*symbol* E_∞). A property of a material, measured as the emittance of a specimen of the material that is thick enough to be completely opaque and has an optically smooth surface.

emittance (*symbol* E, ϵ). **1.** The radiant flux per unit area emitted by a body. **2.** The ratio of the emitted radiant flux per unit area of a sample to that of a **black body** radiator at the same temperature and under the same conditions.

Spectral emittance refers to emittance measured at a specified wavelength.

Because of the two common meanings of *emittance*, it should be defined when used unless the context allows no misinterpretation.

emulsion. In photography, a light-sensitive coating on a film, plate, or paper. See **nuclear emulsion.**

emulsion plate. A plate with a photographic **emulsion** specially designed to permit observation of the individual tracks of **ionizing particles.**

enamel. A thin **ceramic** coating, usually of high glass content, applied to a **substrate,** generally a metal.

Enceladus. A **satellite** of Saturn orbiting at a mean distance of 238,000 kilometers.

encoder = **analog to digital converter.**

end-fire array. A linear **antenna array** whose direction of maximum radiation is along the axis of the array.

energy. Any quantity with dimensions mass $\times$ length squared $\div$ time squared. Compare **entropy.**

energy conversion efficiency. The efficiency with which a **nozzle** converts the energy of the working substance into **kinetic energy,** expressed as the ratio of the kinetic energy of the jet leaving the nozzle to the kinetic energy of a hypothetical ideal jet leaving an ideal nozzle using the same working substance at the same initial state and under the same conditions of velocity and expansion.

energy density. The **sound energy** per unit volume in a **sound wave.** The unit is the erg per cubic centimeter.

energy density spectrum. The square of the **amplitude** of the (complex) **Fourier transform** of an aperiodic function. Sometimes called *energy spectrum.* See **power spectrum.**

energy equation. See **thermodynamic energy equation, mechanical energy equation, total energy equation.**

energy level. Any one of different values of **energy** which a **particle, atom,** or **molecule** may adopt under conditions where the possible values are restricted by quantizing conditions.

During transitions from one energy level to another, quanta of radiant energy are emitted or absorbed, their frequency depending on the difference between the energy levels.

energy management. In rocketry the monitoring of the expenditure of **fuel** for flight **control** and **navigation.**

energy spectrum = **energy density spectrum.**

engine. A machine or apparatus that converts energy, especially heat energy, into work. Also called *motor.*

engine control. Any **control** for regulating the power and speed of an engine, such as the throttle, mixture control, manifold-pressure regulator, fuel-pressure control, supercharger control, etc.

engine-exhaust trail = **exhaust trail.**

engine mount. A structure used for attaching an **engine** to a **vehicle.**

engine spray. That part of a **pad deluge** that is directed at cooling a rocket's engine or engines during **launch.**

English candle = **international candle.**

enhanced radiation. Increased **radio wave** or **thermal** radiation from the sun, of several hours or days duration.

Enhanced radiation is usually accompanied by many **bursts.**

enthalpy. A mathematically defined thermodynamic function of state,

$$h = u + pv$$

where h is specific enthalpy; u is specific internal energy; p is pressure; and v is specific volume. Also called *heat function.*

The change in enthalpy measures the heat imparted to a system during a reversible isobaric process:

$$dh = dq$$

where dq is the heat increment per unit mass. For a perfect gas,

$$dh = c_p dT$$

where c_p is the specific heat at constant pressure and dT is the temperature increment.

entropy. 1. A measure of the extent to which the energy of a system is unavailable. A mathematically defined thermodynamic function of state, the increase in which gives a measure of the energy of a system which has ceased to be available for work during a certain process:

$$ds = (du + pdv)/T \geq dq/T$$

where s is specific entropy; u is specific internal energy; p is pressure; v is specific volume; T is

Kelvin temperature; and q is heat per unit mass. For reversible processes,

$$ds = dq/T$$

In terms of potential temperature θ,

$$ds = c_p\ (d\theta/\theta)$$

where c_p is the specific heat at constant pressure. See **third law of thermodynamics.**

In an adiabatic process, the entropy increases if the process is irreversible and remains unchanged if the process is reversible. Thus, since all natural processes are irreversible, it is said that in an isolated system the entropy is always increasing as the system tends toward equilibrium, a statement which may be considered a form of the second law of thermodynamics.

2. In communication theory, **average information content.**

entry corridor. Depth of the region between two **trajectories** which define the design limits of a vehicle which will enter a planetary **atmosphere.**

envelope. 1. Of a variable, a curve which bounds the values which the **variable** can assume, but does not consider possible simultaneous occurences or correlations between different values. **2.** The bounds within which a certain system can operate as a **flight envelope,** especially a graphic representation of these bounds showing interrelationships of operational parameters.

environment. An external condition or the sum of such conditions, in which a piece of equipment, a living organism, or a system operates as in *temperature environment*, *vibration environment*, or *space environment.*

Environments are usually specified by a range of values, and may be either natural or artificial.

environmental chamber. A chamber in which humidity, temperature, pressure, fluid contents, noise, and movement may be controlled so as to simulate different environments.

environmental lapse rate. The rate of decrease of temperature T with elevation z in the atmosphere, $-\partial T/\partial z$ or occasionally $\partial T/\partial p$, where p is pressure. See **autoconvective lapse rate, superadiabatic lapse rate.**

The concept may be applied to other atmospheric variables (e.g., lapse rate of density) if these are specified. The environmental lapse rate is determined by the distribution of temperature in the vertical at a given time and place and should be carefully distinguished from the **process lapse rate,** which applies to an individual air parcel.

E_1-layer. See **E-layer.**

eosinophils. A type of white blood cell or leukocyte which stains a red color with eosin stain; normally about 2 to 3 percent of white cells in the blood but tending to decrease during stressful situations and thus usable as an index for **stress.**

ephemeris (*plural*, **ephemerides**). A periodical publication tabulating the predicted positions of **celestial bodies** at regular intervals, such as daily, and containing other data of interest to astronomers.

A publication giving similar information useful to a navigator is called an *almanac.*

ephemeris day. 86,400 **ephemeris seconds.** See **ephemeris time.**

ephemeris second (*abbr* **s**). The fundamental unit of time of the International System of Units of 1960: 1/31556925.9747 of the tropical year defined by the mean motion of the sun in longitude at the epoch 1900 January 0 day 12 hours. See **ephemeris time.**

ephemeris time (*abbr* **E.T.**). The uniform measure of time defined by the laws of dynamics and determined in principle from the orbital motions of the planets, specifically the orbital motion of the earth as represented by Newcomb's Tables of the Sun. Compare **universal time.**

Beginning with the volume for 1960 the American Ephemeris and Nautical Almanac uses ephemeris time as the tabular argument in the fundamental ephemerides of the sun, moon, and planets.

A gravitational ephemeris expresses the position of a celestial body as a function of ephemeris time; and, at any instant, the measure of ephemeris time is the value of the argument at which the ephemeris position is the same as the actual position at the instant. The ephemeris time at any instant is obtained from observation by directly comparing observed position of the sun, moon, and planets with gravitational ephemerides of their coordinates; observations of the moon are the most effective and expeditious for this purpose. An accurate determination, however, requires observations over a more or less extended period; in practice, it takes the form of determining the time correction ΔT that must be applied to universal time ($U.T.$) to obtain ephemeris time:

$$E.T. = U.T. + \Delta T$$

The universal time at any instant may be obtained with little delay from observations of the diurnal motions.

The fundamental epoch from which ephemeris time is reckoned is the epoch that Newcomb designated as 1900 January 0, Greenwich mean noon, but which actually is 1900 January 0 day 12 hours E.T.; the instant to which this designation is assigned is the instant near the beginning of the calendar year A.D. 1900 when the geometric mean longitude of the Sun referred to the mean equinox of date was 279 degrees 41 minutes 48.04 seconds. Ephemeris time is the measure of time in which Newcomb's Tables of the Sun agree with observation.

The primary unit of ephemeris time is the tropical year, defined by the mean motion of the sun in longitude at the epoch 1900 January 0 day 12 hours E.T.; its length in ephemeris days is determined by the coefficient of T in Newcomb's expression for the geometric mean longitude of the sun L referred to the mean equinox of date, given among the elements of the sun.

epoch. A particular instant for which certain data are valid, as the data for which an astronomical catalogue is computed.

Eppley pyrheliometer. A **pyrheliometer** of the thermoelectric type. Radiation is allowed to fall on two concentric silver rings, the outer covered with magnesium oxide and the inner covered with lampblack. A system of **thermocouples** (thermopile) is used to measure the temperature difference between the rings. Attachments are provided so that measurements of direct and diffuse solar radiation may be obtained.

This instrument has been adopted by the U.S. Weather Bureau for station use.

Equ, Equl. International Astronomical Union abbreviations for *Equuleus.* See **constellation.**

equation. In astronomy, a small **correction** to observed values to remove the effects of systematic errors in an observation.

equation of state. An equation relating temperature, pressure, and volume of a system in thermodynamic equilibrium.

A large number of such equations have been devised to apply equally to gaseous and liquid phases throughout a wide range of temperatures and pressures. Of these, the simplest are the **perfect gas law** and **Van der Waal** equation.

equation of time. Prior to 1965, the difference between **mean time** and **apparent time,** usually labeled + or − as it is to be applied to mean time to obtain apparent time. After 1965, the correction to be applied to 12 hours + local mean time (LMT) to obtain the local hour angle (LHA) of the sun.

equation of wave motion = wave equation.

equations of motion. A set of equations which give information regarding the motion of a body or of a point in space as a function of time when initial position and initial velocity are known. See **Newton laws of motion, Eulerian coordinates.**

equator. The **primary great circle** of a sphere or spheroid, such as the earth, perpendicular to the **polar axis;** or a line resembling or approximating such a circle.

The terrestrial equator is 90° from the earth's geographical poles; the celestial equator or equinoctial is 90° from the celestial poles; the galactic equator or galactic circle is 90° from the galactic poles. The astronomical equator is a line connecting points having 0° astronomical latitude; the geodetic equator connects points having 0° geodetic latitude. The expression *terrestrial equator* is sometimes applied to the astronomical equator. The geodetic equator is shown on charts. A fictitious equator is a reference line serving as the origin for measurement of fictitious latitude. A transverse or inverse equator is a meridian the plane of which is perpendicular to the axis of a transverse projection. An oblique equator is a great circle the plane of which is perpendicular to the axis of an oblique projection. A grid equator is a line perpendicular to a prime grid meridian at the origin. The magnetic equator or aclinic line is that line on the surface of the earth connecting all points at which the magnetic dip is zero. The geomagnetic equator is the great circle 90° from the geomagnetic poles of the earth.

equatorial bulge. The excess of the earth's equatorial diameter over the polar diameter.

equatorial electrojet. See **electrojet.**

equatorial satellite. A **satellite** whose **orbit** plane coincides, or almost coincides, with the earth's equatorial plane.

equatorial system. A set of **celestial coordinates** based on the **celestial equator** as the primary great circle; usually declination and hour angle or sidereal hour angle. Also called *equinoctial system of coordinates, celestial equator system of coordinates.*

equigeopotential surface = geopotential surface.

equilibrium flow. Gas **flow** in which energy is constant along **streamlines** and composition of the gas at any point is not time dependent.

equilibrium glide. Gliding flight in which the sum of the vertical components of the aerodynamic **lift** and **centrifugal force** is equal to the force of **gravity.**

equilibrium spheroid. The shape that the earth would attain if it were entirely covered by a tideless ocean of constant depth. Compare **geoid.**

equilibrium vapor pressure. The **vapor pressure** of a system in which two or more phases of a substance coexist in equilibrium. See **vapor tension.**

In meteorology the reference is to water substance unless otherwise specified.

equinoctial = celestial equator.

equinoctial colure. That **great circle** of the **celestial sphere** through the celestial poles and equinoxes; the **hour circle** of the vernal equinox.

equinoctial day = sidereal day.

equinoctial point. One of the two points of intersection of the **ecliptic** and the **celestial equator.** Also called *equinox.*

equinoctial system of coordinates = celestial equator system of coordinates.

equinoctial year = tropical year.

equinox. 1. One of the two points of intersection of the **ecliptic** and the **celestial equator,** occupied by the sun when its declination is 0°. Also called *equinoctial point.*

That point occupied on or about March 21, when the sun's declination changes from south to north, is called *vernal equinox, March equinox,* or *first point of Aries;* that point occupied on or about September 23, when the declination changes from north to south, is called *autumnal equinox, September equinox,* or *first point of Libra.*

Equinox is often used to mean *vernal equinox,* when referring to the origin of measurement of **right ascension** and **celestial longitude.**

2. That instant the sun occupies one of the equinoctial points.

equivalent-barotropic atmosphere. See **equivalent-barotropic model.**

equivalent-barotropic model. A model atmosphere characterized by (a) frictionless and adiabatic flow, (b) hydrostatic and **quasi-geostrophic equilibrium,** and in which (c) the vertical shear of the horizontal wind is assumed to be proportional to the horizontal wind itself.

An equivalent-barotropic atmosphere is, accordingly, an atmosphere in which the wind does not change direction with height and consequently one in which the contours and isotherms (on isobaric surfaces, for example) are everywhere parallel. In such an atmosphere, the vertically averaged motions are presumably equivalent to those at some intermediate level, the equivalent-barotropic level. In terms of the motion at this level, assumed to be an **isobaric surface,** the behavior of the equivalent-barotropic model may be described by a single equation (the vorticity equation) in a single unknown (the height of the isobaric surface). See **barotropic vorticity equation.**

equivalent binary digits. 1. The number of **binary** places required to handle the largest quantity which can be handled in some other **notation.** For instance 3.323 binary digits are required to convey information equivalent to that conveyed by one decimal digit. 2. The number of places required to express in **binary notation** a quantity in some other notation.

equivalent foot-candle = foot-lambert.

equivalent pendulum. A device, usually incorporating **accelerometers** and **gyros,** which has the same response to acceleration as a pendulum with a specific period. See **Schuler tuning.**

equivalent potential temperature. The **potential temperature** corresponding to the **adiabatic equivalent temperature:**

$$\theta_e = T_{a,e}\,(1000/p)^{0.286}$$

where θ_e is the equivalent potential temperature; $T_{a,e}$ is the adiabatic equivalent temperature; and p is the pressure in millibars. This temperature is conservative with respect to dry-adiabatic and pseudoadiabatic processes.

equivalent temperature. 1. **Isobaric equivalent temperature;** the temperature that an air parcel would have if all water vapor were condensed out at constant pressure, the latent heat released being used to heat the air,

$$T_{i,e} = T[1 + (Lw/c_pT)]$$

where $T_{i,e}$ is the isobaric equivalent temperature; T is the temperature; w is the mixing ratio; L is the latent heat; and c_p is the specific heat of air at constant pressure. 2. **Adiabatic equivalent temperature;** The temperature that an air parcel would have after undergoing the following (physically unrealizable) process: dry-adiabatic expansion until saturated; pseudo-adiabatic expansion until all moisture is precipitated out; dry-adiabatic compression to the initial pressure. This is the equivalent temperature as read from a thermodynamic chart and is always greater than the isobaric equivalent temperature:

$$T_{a,e} = T \exp\,(Lw/c_pT)$$

where $T_{a,e}$ is the adiabatic equivalent temperature. Also called *pseudoequivalent temperature.*

equivalent width. In spectrography, a measure of the total **absorption** of radiant energy as indicated by an **absorption line** or **absorption band.** Compare **line width.**

The formula for equivalent width W is

$$W = \int_{\lambda_1}^{\lambda} A\,d\lambda$$

where A is the fraction of incident radiation which is absorbed at any wavelength, and λ_1 and λ_2 are wavelengths, *on opposite sides of the line or band,* where the absorption has dropped to zero.

Thus, in a plot of A against λ, the equivalent width represents the area under the curve, or the width of a fictitious line or band which absorbs completely throughout its extent but which absorbs the same total amount of energy as the actual line or brand.

Equl. International Astronomical Union abbreviation for *Equuleus.* See **constellation.**

Equuleus (*abbr* Equ, Equl). See **constellation.**

eradiation. 1. Same as **radiation,** with respect to **emission.** 2. = **terrestrial radiation.**

erase. In computer terminology, to expunge, wipe out, or destroy stored information, usually without destroying the **storage** media, as in demagnetizing a magnetic tape.

erector. A vehicle used to support a **rocket** for transportation and for placing the rocket in an upright position within a **gantry.**

E-region. The region of the **ionosphere** in which the E-layer tends to form. See **atmospheric shell.**

The E-layer has been observed to be subdivided into two or more *layers,* and these are then assigned the designation, E_1, E_2, etc. Patchy and intermittent clouds of fairly high ionization, known as *sporadic E-layers,* also form in the same general region.

erf = probability integral.

erg. The unit of energy or **work** in the **centimeter-gram-second system;** the work performed by a force of 1 dyne acting through a distance of 1 centimeter.

ergometer. An instrument for measuring muscular **work.**

Eri. International Astronomical Union abbreviation for *Eridanus.* See **constellation.**

Erid. International Astronomical Union abbreviation for *Eridanus.* See **constellation.**

Eridanus (*abbr* **Eri, Erid**). See **constellation.**

erosion gage. An instrument for measuring the effect of **dust** and **micrometeors** on materials exposed to space environment.

erratic error. An error caused by an incomplete element in an instrument.

An example of an erratic error is backlash in a gear train.

error. **1.** In mathematics, the difference between the true value and a calculated or observed value.

A quantity (equal in magnitude to the error) added to a calculated or observed value to obtain the true value is called a *correction.*

2. In a computer or data-processing system, any incorrect step, process, or result.

In addition to the mathematical usage, in the computer field the term is also commonly used to refer to machine malfunctions as *machine errors* and to human mistakes as *human errors.* It is frequently helpful to distinguish between these as follows: errors result from approximations used in numerical methods; mistakes result from incorrect programing, coding, data transcription, manual operation, etc.; malfunctions result from failures in the operation of machine components such as gates, flip-flops, amplifiers, etc.

error band. An error value, usually expressed in percent of full scale, which defines the maximum allowable error permitted for a specified combination of **transducer parameters.**

error coefficients. Partial derivatives showing the variation of a function of several **variables,** with one of these variables. These derivatives are used as coefficients of the variables being changed in a series representation of the total variation of the function.

error function = **probability integral.**

error signal. A voltage the magnitude of which is proportional to the difference between an actual and a desired position.

In radar use, error signals are obtained from **selsyns** and from automatic gain control circuits and are used to control a **servo** system so that the resultant motions tend to correct the error.

ertor. The **effective temperature** (radiational) of the earth's **ozone** layer.

erythema. A reddening of the skin due to capillary dilation.

Several forms of erythema can be caused by undue exposure of the human body to weather elements. The most common is sunburn.

E-scan = **E-display.**

escape. Of a particle or larger body: to achieve an **escape velocity** and a flightpath outward from a **primary body** so as neither to fall back to the body nor to **orbit** it.

escape rocket. A small rocket engine attached to the leading end of an escape tower, which may be used to provide additional thrust to the capsule to obtain separation of the capsule from the booster vehicle in an emergency.

escape speed = **escape velocity.**

escape tower. A trestle tower placed on top of a space capsule, which during liftoff connects the capsule to the escape rocket.

The escape tower is of such length as to protect the capsule from the heat of the escape rocket in case the rocket is used to separate the capsule from the booster vehicle during ascent. The tower is ultimately separated from the capsule if ascent is normal.

escape velocity. The **radial speed** which a particle or larger body must attain in order to escape from the gravitational field of a planet or star. When friction is neglected, the escape velocity is

$$\sqrt{2Gm/r}$$

where G is the universal gravitational constant (see **gravitation**); m is the mass of the planet or star; and r is the radial distance from the center of the planet or star. Also called *escape speed.*

Escape velocity from Earth is 7 miles/sec; from Mars it is 3.2 miles/sec; and from the Sun it is 390 miles/sec. In order for a celestial body to retain an atmosphere for long periods of time, the mean velocity of the atmospheric molecules must be considerably below the escape velocity.

E-scope = **E-display.**

E.T. (*abbr*) = **ephemeris time.**

etiology. The doctrine of causes, particularly the causes and reasons for diseases.

E_2-layer. See **E-layer,** note.

Eulerian angles. A system of three angles which uniquely define with reference to one **coordinate system** (e.g., earth axes), the orientation of a second coordinate system (e.g., body axes). Any orientation of the second system is obtainable from that of the first by **rotation** through each of the three angles in turn, the sequence of which is important.

Eulerian coordinates. Any system of **coordinates** in which properties of a **fluid** are assigned to points in space at each given time, without attempt to identify individual **fluid parcels** from one time to the next. See **equations of motion.** Compare **Lagrangian coordinates.**

Eulerian coordinates are to be distinguished from **Lagrangian coordinates.** The particular coordinate system used to identify points in space (Cartesian, cylindrical, spherical, etc.) is quite independent of whether the representation is Eulerian or Lagrangian.

Eulerian correlation. The **correlation** between the properties of a flow at various points

in space at a single instant of time. Sometimes called *synoptic correlation.* Compare **Lagrangian correlation.**

Eulerian equations. Any of the fundamental equations of hydrodynamics expressed in **Eulerian coordinates.** These are so commonly used that the designation *Eulerian* is often omitted.

Europa. A **satellite** of Jupiter orbiting at a mean distance of 671,000 kilometers. Also called *Jupiter II.*

evaporation. The physical process by which a liquid or solid is transformed to the gaseous state; the opposite of condensation. Also called *vaporization.*

In meteorology, *evaporation* usually is restricted in use to the change of water from liquid to gas, while *sublimation* is used for the change from solid to gas as well as from gas to solid.

According to the **kinetic theory** of gases, evaporation occurs when liquid molecules escape into the vapor phase as a result of the chance acquisition of above-average, outward-directed, translational velocities at a time when they happen to lie within about one mean free path below the effective liquid surface. It is conventionally stated that evaporation into a gas ceases when the gas reaches saturation. In reality, net evaporation does cease, but only because the numbers of molecules escaping from and returning to the liquid are equal, that is, evaporation is counteracted by condensation.

Energy is lost by an evaporating liquid; and, when no heat is added externally, the liquid always cools. The heat thus removed is termed the *latent heat of vaporization.*

evaporation coefficient. The ratio of the actual **evaporation rate** to the maximum or **Knudsen rate of evaporation.**

evaporation rate. **1.** The mass of material evaporated per unit time from unit surface of a liquid or solid. **2.** The number of **molecules** of a given substance evaporated per second per square centimeter from the free surface of the condensed phase.

evection. A **perturbation** of the moon in its orbit due to the attraction of the sun. This results in an increase in the **eccentricity** of the moon's orbit when the sun passes the moon's **line of apsides** and a decrease when perpendicular to it. See **lunar inequality.**

Evection amounts to 1 degree 15 minutes in the moon's longitude at maximum.

exchange coefficients. Coefficients of **eddy flux** (e.g., of momentum, heat, water vapor, etc.) in **turbulent flow,** defined in analogy to those of the kinetic theory of gases (see **eddy**). Also called *austausch coefficients, eddy coefficients, interchange coefficients.*

The exchange-coefficient hypothesis states that the mean eddy flux per unit area of a conservative quantity (suitably expressed) is proportional to the gradient of the mean value of this quantity, that is,

$$\text{Mean flux per unit area} = -C_e\,(d\bar{E}/dN)$$

where C_e is the exchange coefficient; E is the mean value of the quantity; and N is the direction normal to the surface. In strict analogy to molecular properties C_e would be constant, for turbulent flow C_e turns out to depend on time and location. See **eddy viscosity diffusivity.**

excitation. **1.** An external force, or other input, applied to a system that causes the system to respond in some way. Also called *stimulus.* **2.** The increase in the internal energy of an atomic or molecular system caused by a collision with another particle of greater energy.

For atoms in a discharge, *excitation* usually refers to increasing the energy level of a bound electron.

excited atom. An atom with one or more of its bound **electrons** in an increased energy level.

exclusive OR circuit. A **circuit** which produces an output **signal** when any one, but not more than one, input is in its prescribed state. Also called *AND-NOT gate.*

exhaust deflecting ring. A type of **jetavator** consisting of a ring so mounted at the end of a **nozzle** as to permit it to be rotated into the exhaust stream.

exhaust stream. The stream of gaseous, atomic, or radiant particles that emit from the **nozzle** of a **rocket** or other reaction engine.

exhaust trail. A **condensation trail** that forms when the water vapor of an aircraft exhaust is mixed with and saturates (or slightly supersaturates) the air in the wake of the aircraft. Exhaust trails are of more common occurrence and of longer duration than **aerodynamic trails.** Also called *engine-exhaust trail.*

exhaust velocity. The velocity of gaseous or other particles (exhaust stream) that exhaust through the **nozzle** or a **reaction engine,** relative to the nozzle.

exobiology. That field of biology which deals with the effects of extraterrestrial environments on living organisms and with the search for extraterrestrial life.

exosphere. The outermost, or topmost, portion of the **atmosphere.** Its lower boundary is the **critical level of escape,** variously estimated at 500 to 1000 kilometers above the earth's surface. Also called *region of escape.* See **atmospheric shell.**

In the exosphere, the air density is so low that the **mean free path** of individual particles depends upon their direction with respect to the local vertical, being greatest for upward moving particles (see **cone of escape, fringe region**). It is only from the exosphere that atmospheric gases can, to any appreciable **extent,** escape into outer space.

exospheric. Of or pertaining to the **exosphere.**

exotic fuel. Any fuel considered to be unusual, as a boron-base fuel.

exotic material. Any structural material which is not presently used in great quantities in conventional applications. Usually, materials with melting points above 3000° F.

expandable space structure. A structure which can be packaged in a small volume for **launch** and then erected to its full size and shape outside the earth's atmosphere.

expansion wave. A simple **wave** or progressive disturbance in the **isentropic flow** of a compressible fluid, such that the pressure and density of a fluid particle decrease on crossing the wave in the direction of its motion. Also called *rarefaction wave.* See **compressional wave.**

expiratory reserve. The volume of air that can be expelled from the lungs after a normal expiration.

explement. An angle equal to 360° minus a given angle. Thus, 150° is the explement of 210° and the two are said to be *explementary.* See **complement, supplement.**

explementary angles. Two angles whose sum is 360°.

explosion. 1. The sudden production of a large quantity of gas, usually hot, from a much smaller amount of a gas, liquid, or solid. 2. Specifically, an explosion, sense 1, produced by combustion of a **fuel** and an **oxidizer.**

The distinction between an explosion, sense 2. and a detonation is that in an explosion the heat release rate and the number of molecules per unit volume increase with time more or less uniformly, whereas a detonation is propagated by an advancing **shock front** behind which exothermic reactions take place and thus is (spatially) nonuniform.

explosion turbine. A **turbine** rotated by gases from an intermittent combustion process taking place in a constant-volume chamber.

explosive bolt. A bolt incorporating an explosive which can be detonated on command, thus destroying the bolt. Explosive bolts are used, for example, in separating a **satellite** from a **rocket.**

explosive decompression. A very rapid reduction of air pressure inside a cabin, coming to a new static condition of balance with the external pressure.

exponential atmosphere. 1. = **isothermal atmosphere.** 2. An atmosphere in which the density is given by

$$\rho = \rho_o e^{-h/H}$$

where ρ is density, ρ_o is density at the datum plane, h is altitude, and H is scale height.

exposure suit. A suit designed to protect a person from a harmful natural **environment,** such as cold water.

extended range Dovap (*abbr* **Extradop**). A **baseline** extension of the **Dovap** system to provide a **coherent** reference to the ground transmitter and all Dovap receivers located beyond line-of-sight to the ground transmitter.

The coherent reference is supplied by a cable and is multiplied up to the proper reference frequency.

extensive air shower = Auger shower.

exterior ballistics. That branch of **ballistics** that deals with the motion of projectiles in flight.

external storage. In computer terminology, **storage** media separate from the machine but capable of retaining information in a form acceptable to the machine, as decks of **punched cards** or removable reels of magnetic tape.

extinction. The attenuation of light; that is, the reduction in **illuminance** of a collimated beam of light as the light passes through a medium wherein **absorption** and **scattering** occur.

extinction coefficient. In meteorology, a measure of the space rate of diminution, or extinction, of any transmitted light; thus, it is the **attenuation coefficient** applied to **visible** radiation. The extinction coefficient ϵ is identified as

$$dI = -\epsilon I \, dx$$

or

$$I = I_0 e^{-\epsilon x}$$

where I is the illuminance (luminous flux density) at the selected point in space, I_0 is the illuminance at the light source, and x is the distance from the source.

When so used, the extinction coefficient equals the sum of the medium's absorption coefficient and scattering coefficient, each computed as a weighted average over all wavelengths in the visible spectrum. As long as scattering effects are primary, as in the lower atmosphere, the value of the extinction coefficient is a function of the particle size of atmospheric suspensoids. It varies in order of magnitude from 10 per kilometer with very low visibility to 0.01 per kilometer in very clear air.

extinction cross section = scattering cross section.

Extradop (*abbr*) = ***extended range Dovap.***

extragalactic. Outside our galaxy, which is the **Milky Way.**

extraordinary ray. The refracted component of a beam of **radiation** split by having passed through a doubly refracting substance. The other component is called the *ordinary ray.* See **magnetic double refraction.**

extraterrestrial life. Life forms evolved and existing outside the terrestrial **biosphere.**

extraterrestrial radiation. In general, **solar radiation** received just outside the earth's atmosphere.

extremely high frequency (*abbr* **EHF**). See **frequency bands.**

extremely low frequency (*abbr* **ELF**). See **frequency bands.**

extreme value. In statistics, the upper or lower bound of the random variable which is not expected to be exceeded by a specified percentage of the population within a given **confidence interval.**

eyeballs in, eyeballs out, eyeballs down, eyeballs up, eyeballs left, eyeballs right. See **physiological acceleration.**

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F

facsimile. In electrical communications, the process, or the result of the process, by which fixed graphic material including pictures or images is scanned and the information converted into signals which are used either locally or remotely to produce in record form a likeness (facsimile) of the subject copy.

faculae. Large patches of bright material forming a veined network in the vicinity of **sunspots.** They appear to be more permanent than sunspots and are probably due to elevated clouds of luminous gas.

fade. Of a radiant energy signal, to decrease, often temporarily, in received **signal strength** without a change of receiver controls.

The opposite is *build.*

fadeout. A type of **fading** in which the received signal strength is reduced to a value below the **noise level** of the receiver. The most common cause of fadeout is a disturbed **ionosphere.** Also called *radio fadeout, Dellinger effect, Mögel-Dellinger effect.* See **blackout.**

fading. The variation of radio **field strength** caused by changes in the transmission medium with time.

Fahrenheit temperature scale (*abbr* **F**). A temperature scale with the **ice point** at 32° and the **boiling point** of water at 212°.

Conversion with the Celsius (**centigrade**) temperature scale (*abbr* C) is by the formula

$$F = 9/5\,C + 32$$

fail safe system. A system used to minimize risk in case of a malfunction.

fall. Of a spacecraft or spatial body, to drop toward another spatial body under the influence of the latter's **gravity.**

fallaway section. A section of a **rocket** vehicle that is cast off and separates from the vehicle during flight, especially such a section that falls back to the earth.

false horizon. See **horizon,** note.

fan. **1.** (**a**) Any vaned rotary device for producing a current or stream of air. (**b**) Specifically, a multivaned wheel or rotor used to take in air in a bypass engine or **ducted-fan engine.** It may be either a mere blower or a low-pressure compressor. See **ducted fan.** **2.** A propeller, especially when the emphasis is upon its function of moving air rather than propelling.

fanned-beam antenna. A **unidirectional antenna** so designed that transverse cross sections of the major **lobe** are approximately elliptical.

fanning beam. A radiant energy beam, as a **radar** beam, which sweeps back and forth over a limited arc.

farad (*abbr* **f**). The unit of electrical capacitance, the capacitance of a condenser between the plates of which there is a difference of potential of 1 volt when it is charged by a quantity of electricity equal to 1 **coulomb.**

Faraday constant (*symbol* ***F***). The product of the Avogadro constant N_A and the elementary charge e, $F = N_Ae = 9.64870$ coulombs per mol. See **physical constants,** tables.

fast ion = **small ion.**

fast neutron. A neutron of 100,000 electron-volts or greater energy.

fast reactor. A **reactor** containing no **moderator,** so that all the **fissions** take place at energies on the order of 100,000 electron-volts or higher.

fatigue. **1.** A weakening or deterioration of metal or other material occurring under load, especially under repeated cyclic, or continued loading.

Self-explanatory compounds include: *fatigue crack, fatigue failure, fatigue load, fatigue resistance, fatigue test.*

2. State of the human organism after exposure to any type of physical or psychological stress (e.g., pilot fatigue).

fatigue strength. The maximum **stress** that can be sustained for a specified number of cycles without failure, the stress being completely reversed within each cycle unless otherwise stated. Also called *fatigue limit.*

F-corona = **Fraunhofer corona.**

F-display. In radar, a rectangular **display** in which a target appears as a centralized **blip** when the radar antenna is aimed at it. Horizontal and vertical aiming errors are respectively indicated by the horizontal and vertical displacement of the blip. Also called *F-scan, F-scope, F-indicator.*

feed. **1.** To provide a **signal.** **2.** The point at which a signal enters a circuit or device, as *antenna feed.* **3.** The signal entering a circuit or device; **input.**

feedback. **1.** The return of a portion of the **output** of a device to the **input;** positive

feedback adds to the input, negative feedback subtracts from the input. **2.** Information, as to progress, results, etc., returned to an originating source. **3.** In aeronautics, the transmittal of forces initiated by aerodynamic action on control surfaces or rotor blades to the cockpit **controls;** the forces so transmitted.

feedback control loop. A closed transmission path (loop), which includes an active **transducer** and which consists of a forward path, a feedback path, and one or more mixing points arranged to maintain a prescribed relationship between the loop **input** signal and the loop **output** signal.

feedback control system. A **control** system, comprising one or more **feedback control loops,** which combines functions of the controlled signals with functions of the **commands** to tend to maintain prescribed relationships between the commands and the controlled signals.

feedback path. In a **feedback control loop** the transmission path from the loop **output** signal to the loop **feedback** signal.

feel. The sensation or impression that a pilot has or receives as to his, or his craft's, attitude, orientation, speed, direction of movement or acceleration, or proximity to nearby objects, or, as most often used, as to the aircraft's stability and responsiveness to control. See **control feel.**

femto (*abbr* **f**). A prefix meaning multiplied by 10^{-15}.

fence. 1. A line of **readout** or **tracking** stations for pickup of signals from an orbiting **satellite. 2.** A line or network of radar or radio stations for detection of a satellite in orbit. **3.** A stationary plate or vane projecting from the upper surface of an airfoil, substantially parallel to the airflow, used to prevent spanwise flow.

Fermat principle. The principle which states that the path along which **electromagnetic radiation** travels between any two points will be that path for which the elapsed time for the travel is a minimum. See **multipath transmission.**

fermi (*abbr* **f**). A unit of length equal to 10^{-13} centimeters.

fictitious. In cartography, pertaining to or measured from an arbitrary reference line as in *fictitious equator*, *fictitious latitude*, *fictitious longitude.*

Transverse, oblique, and grid map projections are examples of fictitious projections.

fictitious year. The period between successive returns of the sun to a **sidereal hour angle** of 80° (about January 1). Also called *Besselian year*, *Bessel fictitious year.*

The length of the fictitious year is the same as that of the **tropical year,** since both are based upon the position of the sun with respect to the **vernal equinox.**

fidelity. The accuracy to which an electrical system, such as a radio, reproduces at its **output** the essential characteristics of its **input signal.**

fiducial mark. An internally generated identification mark on a film; two or more of these are generally used for orienting a film for reading, and for determining the geometric center of the film.

The L-shaped corner marks and the + mark near the picture center, which are on the focal plane of the Tiros vidicon camera are fiducial marks. Their appearance on the image permits various calibrations such as determination of the degree of enlargement needed to fit the picture to the rectification grids, etc.

field. A region of space within which each point has a definite value of a given physical or mathematical quantity has some definite value.

One may speak of a *gravitation field, magnetic field, electric field, pressure field, temperature field,* etc. If the quantity specified at each point is a vector quantity, the field is said to be a *vector field.*

field brightness = adaptation luminance.

field intensity = field strength.

field luminance = adaptation luminance.

field strength. 1. For any physical **field,** the **flux density, intensity,** or **gradient** of the field at the point in question. Also called *field intensity.*

Although field *intensity* is commonly used, it should be noted that this does not follow the strict radiometric definition of intensity, i.e., flux per unit solid angle.

2. = signal strength, in radar. **3. = electric field strength.**

filamentary structure. A shell or membrane structure constructed of woven or layered filaments embedded in a suitable matrix.

film cooling. The cooling of a body or surface, such as the inner surface of a rocket **combustion chamber,** by maintaining a thin fluid layer over the affected area. Compare **transpiration cooling.**

filter = wave filter.

filtering. 1. The decomposition of a **signal** into its **harmonic** components. **2.** The separation of a wanted component of a **time series** from any unwanted residue (noise).

fin. 1. A fixed or adjustable **airfoil** or **vane** attached longitudinally to an aircraft, rocket, or similar body to provide a stabilizing effect. **2.** A projecting flat plate or structure, as a *cooling fin.*

final mass. The mass of a **rocket** after its **propellants** are consumed.

F-indicator = **F-display.**

fine data channel. The **channel** of a **trajectory-measuring system** delivering accurate but ambiguous data as opposed to the coarse channel needed to resolve the ambiguity.

fine pressure = **inlet pressure.**

fineness ratio. The ratio of the length of a body to its maximum diameter, or, sometimes, to some equivalent dimension—said especially of a body such as an airship hull or rocket.

fire. 1. To ignite a **rocket engine.**

Usage is sometimes restricted to period of main chamber burning when small igniter chambers are used, especially with igniter idle provisions where the igniter may burn for some significant period prior to main chamber fire.

2. To **launch** a rocket.

fireball. A bright **meteor** with **luminosity** which equals or exceeds that of the brightest planets.

fire point. The temperature at which a substance, as lubricating oil, will give off a vapor that will burn continuously after ignition. Compare **flashpoint.**

firing. 1. The action or event of igniting a **rocket engine.** 2. The action or event of launching a rocket.

firing chamber = **combustion chamber.**

first law of thermodynamics. A statement of the conservation of energy for **thermodynamic** systems (not necessarily in equilibrium). The fundamental form requires that the heat absorbed by the system serve either to raise the internal energy of the system or to do work on the environment:

$$dq = du + dw$$

where dq is the heat added per unit mass; du is the increment of specific internal energy; and dw is the specific work done by the system on the environment. Although dq and dw are not perfect differentials, their difference, du, is always a perfect differential. Example of the application of this equation: in an adiabatic free expansion of gas into a vacuum, all three terms are zero.

For reversible processes the mechanical work is equal to the expansion against the pressure forces, i.e.,

$$dw = pdv$$

where p is the pressure and v is the specific volume. For a perfect gas, the internal energy change is proportional to the temperature change,

$$du = c_v dT$$

where c_v is the specific heat at constant volume and T is the Kelvin temperature. Therefore, the form of the first law usually used in meteorological applications is

$$dq = c_v dT + pdv$$

Use of the equation of state yields an alternative form,

$$dq = c_p dT - dp$$

where c_p is the specific heat at constant pressure.

For open systems the variation of total rather than specific quantities is important:

$$dQ = dU + pdV - hdm$$

where Q is the total heat; U is the total internal energy; V is the volume; m is the mass of the system; and h is the specific enthalpy.

If a system contains the possibility of nonmechanical work, such as work done against an electric field, this work must be included in the first law.

See **second law of thermodynamics, third law of thermodynamics, energy equations.**

first point of Aries = **vernal equinox.**

first point of Cancer = **summer solstice.**

first point of Capricornus = **winter solstice.**

first point of Libra = **autumnal equinox.**

first quarter. The **phase** of the moon when it is near east **quadrature,** when the western half of it is visible to an observer on the earth. See **phases of the moon.**

fishbone antenna. An **antenna** consisting of a series of coplanar elements arranged in colinear pairs, loosely coupled to a balanced transmission line.

fission. The splitting of an **atomic nucleus** into two more-or-less equal fragments.

Fission may occur spontaneously or may be induced by capture of bombarding particles. In addition to the fission fragments, neutrons and gamma rays are usually produced during fission.

fissionable. Having the property of certain **atomic nuclei,** such as some **isotopes** of uranium and plutonium, of capturing neutrons and thereupon splitting into two particles with great kinetic energy.

The term properly is applicable to nuclei that undergo fission by neutrons of thermal energies; but it sometimes is applied loosely to cases where the neutron must be of high energy, as in *U^{238} is fissionable by fast neutrons.*

Fitzgerald-Lorentz contraction. A hypothesis that all measuring rods contract in the direction of motion in the ratio

$$\sqrt{1 - (u^2/c^2)}/1$$

where u is the speed of motion and c is the speed of light.

fix. In navigation, a relatively accurate **position** determined without reference to any former position. It may be classed as visual, sonic, celestial, electronic, radio, hyperbolic, loran, radar, etc., depending upon the means of establishing it.

fixed-area exhaust nozzle. On a jet engine, an exhaust **nozzle** exit opening which remains constant in area. Compare **variable-area exhaust nozzle.**

fixed point. 1. **Positional notation** in which corresponding places in different quantities are occupied by coefficients of the same power of

the base. Contrast to **floating point.** **2.** A notation in which the **base point** is assumed to remain fixed with respect to one end of the numeric expressions.

fixed satellite. A **satellite** that orbits the earth from west to east at such a speed as to remain fixed over a given place on the earth's equator at approximately 35,900 kilometers altitude. See **stationary orbit, 24-hour satellite, synchronous satellite.**

flame attenuation. **Attenuation** of a radio **signal** by the **ionization** produced in the rocket exhaust.

flame bucket. A deep cavelike construction built beneath a **launcher,** open at the top to receive the hot gases of the rocket positioned above it, and open on one or three sides below, with a thick metal fourth side bent toward the open sides so as to deflect the exhausting gases. See **flame deflector.**

flame deflector. **1.** In a vertical **launch,** any of variously designed obstructions that intercept the hot gases of the **rocket engine** so as to deflect them away from the ground or from a structure.

The flame deflector may be a relatively small device fixed to the top surface of the pad surrounded by the framework of the launcher, or it may be a heavily constructed piece of metal mounted as a side and bottom of a flame bucket. In the latter case, the deflector may be perforated with numerous holes connected with a source of water, bending at an angle of about 45° into the line of the exhaust stream. During thrust buildup and the beginning of the launch, a deluge of water pours from the holes in such a deflector to keep it from melting. See **deluge collection pond.**

2. In a captive test, an elbow in the exhaust conduit or **flame bucket** that deflects the flame into the open.

flame tube = inner liner.

Flamsteed number. A number sometimes used with the possessive form of the Latin name of the **constellation** to identify a star, as *72 Ophiuchi.*

The Flamsteed number is used for stars numbered in Flamsteed's British Catalogue of 1725. For stars which do not appear in Flamsteed's catalog, numbers from other catalogs are used. See **Bayer letter.**

flare. **1.** A bright eruption from the sun's chromosphere. Compare **prominence.**

Flares may appear within minutes and fade within an hour. They cover a wide range of intensity and size, and they tend to occur between **sunspots** or over their penumbrae.

Flares are related to radio **fadeouts** and terrestrial magnetic disturbances.

Flares eject high energy **protons** which present a serious hazard to men in unshielded spacecraft.

2. Pyrotechnic devices used for signalling or to provide illumination. **3.** An expansion at the end of a cylindrical body as at the base of a rocket.

flashback. A reversal of flame in a system, counter to the usual flow of the combustible mixture.

flashpoint. The temperature at which a substance, as fuel oil, will give off a vapor that will flash or burn momentarily when ignited. Compare **fire point.**

flattening. Of the earth, the ratio of the difference between the equatorial radius (major semiaxis) and the polar radius (minor semiaxis) of the earth to the equatorial radius. Also called *compression.* See **astronomical constants.**

The flattening of the earth is the ellipticity of the spheroid and equals the ellipticity of the ellipse forming a meridional section of the spheroid. If a and b represent the major and minor semiaxes of the spheroid, and f is the flattening of the earth,

$$f = (a - b)/a$$

The magnitude of the flattening is sometimes expressed by stating the numerical value of the reciprocal of the flattening, $a/(a - b)$.

F-layer. See **ionosphere.**

flicker control. **Control** of an aircraft, rocket, etc. in which the control surfaces are deflected to their fullest degree with any motion of the remote control. Compare **proportional control.** See **bang-bang control.**

flight. **1.** The movement of an object through the atmosphere or through space, sustained by aerodynamic, aerostatic, or reaction forces, or by orbital speed; especially, the movement of a man-operated or man-controlled device, such as a rocket, a space probe, a space vehicle, or aircraft. **2.** An instance of such a movement.

flight attitude. The attitude of an aircraft, rocket, etc., in flight; specifically, the attitude of an aircraft with respect to the **relative wind.**

flight characteristic. A **characteristic** exhibited by an aircraft, rocket, or the like in flight, such as a tendency to stall or to yaw, an ability to remain stable at certain speeds, etc.

flight control system = vehicle control system.

flight Mach number. A **free-stream Mach number** measured in flight as distinguished from one measured in a **wind tunnel.**

flightpath. The path made or followed in the air or in space by an aircraft, rocket, etc.; the continuous series of positions occupied by a flying body; more strictly, the path of the center of gravity of the flying body, referred to the earth or other fixed reference.

flightpath angle. The angle between the **horizontal** and a tangent to the **flightpath** at a point.

flight profile. A graphic portrayal or plot of the flight path of an aeronautical vehicle in the vertical plane.

flight simulator. A training device or apparatus that simulates certain conditions of actual flight or of flight operations.

flight space. The space above and beyond the earth's surface now used, or potentially to be used, for **flight** of aircraft, spacecraft, or rockets.

flight test. **1.** A test by means of actual or attempted flight to see how an aircraft, spacecraft, space-air vehicle, or missile flies. **2.** A test of a component part of a flying vehicle, or of an object carried in such a vehicle, to determine its suitability or reliability in terms of its intended function by making it endure actual **flight.**

flight test vehicle. A test vehicle for the conduct of **flight tests,** either to test its own capabilities or to carry equipment requiring flight test.

flip-flop. **1.** A device having two stable states and two input terminals (or types of input signals) each of which corresponds with one of the two states. The **circuit** remains in either state until caused to change to the other state by application of the corresponding signal. **2.** A similar bistable device with an input which allows it to act as a single-stage **binary counter.**

floating point. In computer operations, a **positional notation** in which corresponding places in different quantities are not necessarily occupied by coefficients of the same power of the base. Compare **fixed point.**

Floating point corresponds to multiplication using powers of 10; for example, 186,000 can be represented as 1.86×10^5. By shifting the point so that the number of significant digits in any quantity does not exceed machine capacity, widely varying quantities can be handled. The scale factor may be fixed for each problem, or indicated along with the digits and sign for each quantity.

flocculi. Patches of relatively dense, dark or bright clouds in the sun's atmosphere. They appear in photographs taken with the **spectroheliograph.**

The emission spectra usually studied are those of calcium and hydrogen; e.g., bright calcium flocculi, and dark or bright hydrogen flocculi. Measures of the extent of these three kinds of flocculi are tabulated in the *quarterly Bulletin of Character Figures of Solar Phenomena*, Zürich, Int. Astron. Union.

flotation gear. **1.** Gear or apparatus, commonly inflatable bags, vests, rafts, and the like, carried aboard a vehicle to support the vehicle or persons if downed in water. **2.** A buoyant landing gear, usually called *floats.*

flow. A stream or movement of air or other **fluid,** or the rate of fluid movement, in the open or in a duct, pipe, or passage; specifically, an **airflow.**

flow chart. A graphical representation of a sequence of operations using symbols to represent the operations.

A flow chart is a more detailed representation than a diagram.

fluctuation velocity = eddy velocity.

fluid. A substance which, when in static equilibrium, cannot sustain a **shear** stress; a liquid or a gas.

This concept is only approximated by actual liquids and gases.

fluidity. Reciprocal of **viscosity.**

fluid parcel. In any **fluid,** an imaginary portion of that fluid which for theoretical studies may be considered to have all the basic dynamic and thermodynamic properties of the fluid but which is small enough so that its motion with respect to the surrounding fluid does not induce marked compensatory movements. Also called *parcel.*

The size of the fluid parcel cannot be given precise numerical definition but it must be large enough to contain a great number of molecules and small enough so that the properties assigned to it are approximately uniform within it.

fluorescence. **Emission** of light or other radiant energy as a result of and only during **absorption** of **radiation** of a different wavelength from some other source. Also called *photoluminescence.* See **luminescence.** Compare **phosphorescence.**

flutter. An **aeroelastic** self-excited vibration in which the external source of energy is the **airstream** and which depends on the elastic, inertial and dissipative forces of the system in addition to the **aerodynamic forces.**

flux. **1.** The rate of **flow** of some quantity, often used in reference to the flow of some form of **energy.** Also called *transport.* See **power.** **2.** In nuclear physics generally, the number of **radioactive particles** per unit volume times their mean velocity.

flux density. The **flux** (rate of flow) of any quantity, usually a form of **energy,** through a unit area of specified surface. (Note that this is not a volumetric density like **radiant density.**) Compare **luminous density.**

In radar, flux density commonly is referred to as *power density*. It is essential to understand that the flux density of radiation is in no sense a vector quantity, because it is the sum of the flux corresponding to all ray directions incident upon one *side* of the unit area.

flux-density threshold = threshold illuminance.

flyby. An interplanetary mission in which the

vehicle passes close to the target planet but does not impact it or go into orbit around it.

flying spot. A rapidly moving spot of light, usually generated by a **cathode-ray tube** and used to **scan** a surface containing visual information.

flying test bed. An aircraft, rocket, or other flying **vehicle** used to carry objects or devices being flight tested.

FM (*abbr*) = ***frequency modulation.***

FM/AM (*abbr*). **1. Amplitude modulation** of a **carrier** by subcarrier(s) which is (are) frequency modulated by information. **2.** Alternate FM or AM operation.

FM/FM (*abbr*). **Frequency modulation** of a **carrier** by subcarrier(s) which is (are) frequency modulated by information.

FM/PM (*abbr*). **Phase modulation** of a **carrier** by subcarrier(s) which is (are) frequency modulated by information.

foamed plastics. Plastic materials, used primarily for insulation, in which a foaming agent is used to provide minute voids to improve insulating qualities—often foamed in place within the structure.

focal length. The distance between the optical center of a lens, or the surface of a mirror, and its **focus.**

focal plane. A plane parallel to the plane of a lens or mirror and passing through the **focus.**

focal point = **focus,** in optics.

focus (*plural* **focuses**). **1.** That point at which parallel rays of light meet after being refracted by a lens or reflected by a mirror. Also called *focal point.* **2.** A point having specific significance relative to a geometrical figure. See **ellipse, hyperbola, parabola.**

folded dipole antenna. An **antenna** composed of two parallel, closely spaced **dipole antennas** connected at their ends with one of the dipole antennas fed at its center.

folding fin. A **fin** hinged at its base to lie flat, especially a fin on a **rocket** that lies flat until the rocket is in flight.

follow-on. Any object, group of objects, technique, or procedure considered to be a second or subsequent generation in the development of the object, group of objects, technique, or procedure. See **generation.**

foot (*abbr* **ft**). The foot (international) is exactly 0.3048 meter.

The American Survey foot is 0.3048006 meter.
The old U. S. foot, used prior to July 1, 1959, was 0.3048006 meter.

foot-candle (*abbr* **ft-c**). A unit of **illuminance,** incident light, or **illumination** equal to 1 lumen per square foot. This is the illuminance provided by a light source of one candle at a distance of 1 foot, hence the name. Compare **lux, phot.**

Full sunlight with zenith sun produces an illuminance of the order of 10,000 foot-candles on a horizontal surface at the earth's surface. Full moonlight provides an illuminance of only about 0.02 foot-candle also at earth's surface. Adequate illumination for steady reading is taken to be about 10 foot-candles; that for close machine work is about 30 to 40 foot-candles.

foot-lambert (*abbr* **ft-l**). A unit of **luminance** (or brightness) equal to $1/\pi$ candle per square foot, or 1 lumen per square foot.

In Great Britain this is also called the *equivalent foot-candle.*

foot-to-head acceleration. See **physiological acceleration.**

footward acceleration. See **physiological acceleration.**

For, Forn. International Astronomical Union abbreviations for ***Fornax.*** See **constellation.**

forbidden line. A line in a **spectrum** resulting from a transition from a **metastable** state within an atom. Forbidden lines are not found in ordinary sources, but may be conspicuous in very large bodies of rarefied gas where the time interval between collisions of atoms is long.

Forbidden lines of oxygen appear, for **example,** in the **aurora.**

Forbush decrease. The observed decrease in **cosmic ray** activity in the earth's atmosphere about a day after a **solar flare.**

The Forbush decrease is believed to be caused by a shielding effect of the magnetic fields contained in the plasma cloud emitted from the sun at the time of the flare.

force (*symbol* ***F***). The cause of the **acceleration** of material bodies measured by the rate of change of **momentum** produced on a free body.

force balance transducer. A **transducer** in which the output from the sensing member is amplified and fed back to an element which causes the force-summing member to return to its rest position.

forced oscillation. An **oscillation** of a system in which the response is imposed by the **excitation.** If the excitation is periodic and continuing, the oscillation is steady state. Also called *forced vibration.*

forced vibration = **forced oscillation.**

forced wave. See **resonance.**

force function. The negative of **potential,** sense **1.**

formability. The relative ease with which a metal can be shaped through plastic deformation.

Forn. International Astronomical Union abbreviation for *Fornax*. See **constellation.**

Fornax (*abbr* **For, Forn**). See **constellation.**

forward acceleration. See **physiological acceleration.**

forward scatter. The **scattering** of **radiant energy** into the hemisphere of space bounded by a plane normal to the direction of the incident radiation and lying on the side toward which the incident radiation was advancing; the opposite of **backward scatter.**

In **Rayleigh scattering,** forward scatter accounts for half of the total. As the particle size increases above the Rayleigh limit, an increasing fraction of the total scattering is forward scattering.

Fourier analysis. The representation of physical or mathematical data by the use of the **Fourier series** or **Fourier integral.**

Fourier coefficients. See **Fourier series.**

Fourier integral. The representation of a function f(x) for all values of x in terms of infinite integrals in the form

$$f(x) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(t) \cos\,[u(t - x)]\; dt\; du$$

See **Fourier transform, Fourier series.**

Fourier series. The representation of a function $f(x)$ in an interval $(-L, L)$ by a series consisting of sines and cosines with a common period $2L$, in the form,

$$f(x) = A_0 + \sum_{n=1}^{\infty} \left(A_n \cos \frac{n\pi x}{L} + B_n \sin \frac{n\pi x}{L} \right) \qquad (-L < x < L)$$

where the Fourier coefficients are defined as

$$A_0 = \frac{1}{2L} \int_{-L}^{L} f(x)\, dx$$

$$A_n = \frac{1}{L} \int_{-L}^{L} f(x) \cos \frac{n\pi x}{L}\, dx$$

and

$$B_n = \frac{1}{L} \int_{-L}^{L} f(x) \sin \frac{n\pi x}{L}\, dx$$

When $f(x)$ is an even function, only the cosine terms appear; when $f(x)$ is odd, only the sine terms appear.

The conditions on $f(x)$ guaranteeing convergence of the series are quite general, and the series may serve as a root-mean-square approximation even when it does not converge.

If the function is defined on an infinite interval and is not periodic, it is represented by the Fourier integral. By either representation, the function is decomposed into periodic components whose frequencies constitute the spectrum of the function. The Fourier series employs a discrete spectrum of wavelengths $2L/n (n = 1, 2, \ldots)$; the Fourier integral requires a continuous spectrum.

See **Fourier transform.**

Fourier transform. An analytical transformation of a function $f(x)$ obtained (if it exists) by multiplying the function by e^{-iux} and integrating over all x,

$$F(u) = \int_{-\infty}^{\infty} e^{-iux} f(x)\, dx \quad (-\infty < u < \infty)$$

where u is the new variable of the transform $F(u)$ and $i^2 = -1$. If the Fourier transform of a function is known, the function itself may be recovered by use of the inversion formula:

$$f(x) = 1/2\pi \int_{-\infty}^{\infty} e^{iux} F(u)\, du \quad (-\infty < x < \infty)$$

The Fourier transform has the same uses as the **Fourier series**: for example, the integrand $F(u) \exp{(iux)}$ is a solution of a given linear differential equation, so that the integral sum of these solutions is the most general solution of the equation.

When the variable u is complex, the Fourier transform is equivalent to the **Laplace transform.**

See **Fourier integral, spectral function.**

fourth state of matter = **plasma.**

fovea. The central part of the retina, which contains a high concentration of color-sensitive receptors known as *cones.* See **foveal vision.**

foveal vision. Vision in which the eye is so oriented toward the pertinent light source as to have the light fall upon that central portion of the retina called the *fovea.* Also called *photopic vision.*

Foveal vision permits much higher resolution than does parafoveal vision and is the normal mode of seeing under daytime conditions.

Fraunhofer corona. That portion of the radiation from the **corona** consisting of the **Fraunhofer spectrum** scattered by interplanetary particles. Compare **K-corona, L-corona.**

Fraunhofer lines. Dark lines in the **absorption spectrum** of **solar radiation** due to absorption by gases in the outer portions of the sun and in the earth's atmosphere.

Fraunhofer lines are designated by letters, as the *K-line,* or by wavelength, as the *4046-angstrom line of iron.*

The major Fraunhofer lines are:

	angstroms	*Line due to*
A	7594	Telluric oxygen
B	6867	Telluric oxygen
C	6563	hydrogen, H_α
D_1	5896	sodium
D_2	5890	sodium
D_3	5876	helium
E	5270	iron and calcium
b_1	5184	magnesium
F	4861	hydrogen, H_β
G	4308	iron (and calcium)
H	3968	calcium
K	3934	calcium

Fraunhofer region. That region of the **field** in which the energy flow from an **antenna** proceeds essentially as though coming from a point source located in the vicinity of the antenna.

If the antenna has a well-defined aperture a in a given aspect, the Fraunhofer region in that aspect is commonly taken to exist at distances greater than $2a^2/\lambda$ from the aperture, λ being the wavelength.

Fraunhofer spectrum. The visible solar spectrum.

free air = free atmosphere.

free atmosphere. That portion of the earth's **atmosphere,** above the **planetary boundary layer,** in which the effect of the earth's surface friction on the air motion is negligible, and in which the air is usually treated (dynamically) as an ideal fluid. The base of the free atmosphere is usually taken as the **geostrophic wind** level. Also called *free air.*

free electron. An **electron** which is not bound to an atom.

free fall. **1.** The fall or drop of a body, such as a rocket, not guided, not under thrust, and not retarded by a parachute or other braking device. **2.** The free and unhampered motion of a body along a Keplerian **trajectory,** in which the force of **gravity** is counterbalanced by the force of **inertia.** See **weightlessness.**

free field. An **isotropic,** homogeneous, sound field free from bounding surfaces. Also called *free sound field.*

free flight. Unconstrained or unassisted **flight,** as: **(a)** the flight of a rocket after consumption of its propellant or after motor shutoff; **(b)** the flight of an unguided projectile; **(c)** the flight in certain kinds of wind tunnel of an unmounted model.

free-flight angle. The angle between the **horizontal** and a line in the direction of motion of a flying body, especially a **rocket,** at the beginning of **free flight.**

free-flight trajectory. The path of a body in free fall.

free-flow area = void fraction.

free gyro. **1.** A two-degree-of-freedom **gyro** whose spin axis may be oriented in any specified attitude.

In a free gyro, output signals are produced by gimbal angular displacements which correspond to components of the angular displacement of the base.

2. A **gyro** not provided with an erection system, i.e., a gyro free to move about its axes.

free jet. A fluid **jet** without solid boundaries, such as a jet discharging into the open.

free molecule flow. **1.** A **flow** regime in aerodyamics in which molecules emitted from an object, as it passes through a resistive medium, do not affect the flow of oncoming molecules by scattering interactions, i.e., the **mean free path** of the emitted molecules is much longer than a characteristic linear dimension of an object. **2. Flow** about a body in which the number of **collisions** between the molecules of the fluid is negligible compared with the collisions between these molecules and the body. Also called *free molecular flow.* See **rarefied gas dynamics,** note.

free oscillation. **Oscillation** of a system in the absence of external forces.

free progressive wave. A **wave** in a medium free from boundary effects. A free wave in a steady state can only be approximated in practice. Also called *free wave.*

free radical. An **atom** or group of atoms broken away from a stable compound by application of external energy, and, although containing unpaired **electrons,** remaining free for transitory or longer periods.

Interest centers on three radicals, atomic hydrogen (H), atomic nitrogen (N), and the amine radical (NH). In their free state, they are highly active, combining with each other or with other substances to form other stable molecules, and yielding in the process energies well in excess of those available from conventional chemical fuels. Their use in propulsive systems, depends upon their being isolated and available in bulk, either in pure form or dissolved in a desired concentration in another fuel. See **areoduct.**

free sound field = free field.

free space. An ideal, perfectly homogeneous medium possessing a **dielectric constant** of unity and in which there is nothing to reflect, refract or absorb energy. A perfect vacuum possesses these qualities. Compare **homogeneous atmosphere.**

Radio signal strength measurements are often expressed in terms of decibels above or below free-space values at a given distance from the transmitter. A free-space radiation pattern would show only the minor and major lobes of the antenna and not the interference pattern normally produced by reflection from the earth's surface.

free stream. **1.** The stream of **fluid** outside the region affected by a body in the fluid. **2.** Pertaining to the free stream, sense **1,** as in *free-stream dynamic pressure, free-stream flow, free-stream Mach number, free-stream static pressure, free-stream temperature, free-stream turbulence, free-stream velocity.* See **remote velocity.**

free-stream capture area. The cross-sectional area of a column of air swallowed by a **ramjet** engine.

free streamline. A **streamline** separating **fluid** in motion from fluid at rest.

Both pressure and speed are constant along a free streamline.

free turbine. In a turbine engine, a **turbine wheel** that drives the output shaft and is not connected to the shaft driving the **compressor.**

free-vortex compressor. An **axial-flow compressor** designed so as to impart to the fluid tangential velocities that are inversely proportional to the distance from the axis of rotation, as in a **vortex.**

free wave. **1.** Any **wave** not acted upon by any external force except for the initial force that created it. **2.** = **free progressive wave.**

freezeout method. A method for controlling **humidity** by passing moist air over a cold surface, thus condensing and freezing out water vapor and possibly carbon dioxide.

F-region. The general region of the ionosphere in which the F_1-layer and F_2-layer tend to form. See **ionosphere.**

frequency (*symbol f*). Of a function periodic in time, the reciprocal of the primitive **period.** The unit is the **cycle** per unit time and must be specified.

In the International System the cycle per second is called the hertz (Hz).

frequency assignment. The specific **frequency** or frequencies authorized by competent authority; expressed for each radio channel by: (**a**) the authorized **carrier frequency,** the **frequency tolerance,** and the authorized emission-bandwidth, (**b**) the authorized emission-bandwidth in reference to a specific assigned frequency (when a carrier does exist), or (**c**) the authorized **frequency band** (when a carrier does not exist).

frequency band. A continuous range of frequencies extending between two limiting frequencies.

Specific frequency bands used in radio and radar are often designated by names, numbers, or letters. The band designations as decided upon by the Atlantic City Radio Convention of 1947 and later modified by Comite Consultatif International Radio (CCIR) Recommendation No. 142 in 1953 are:

Band number	Frequency range	Metric subdivision waves	Atlantic City frequency subdivision	
	kc			
4	3– 30	Myriametric	Very-low	VLF
5	30– 300	Kilometric	Low	LF
6	300– 3,000	Hectometric	Medium	MF
7	3,000– 30,000	Decametric	High	HF
	mc			
8	30– 300	Metric	Very-high	VHF
9	300– 3,000	Decimetric	Ultra-high	UHF
10	3,000– 30,000	Centimetric	Super-high	SHF
11	30,000– 300,000	Millimetric	Extremely high	EHF
12	300,000–3,000,000	Decimillimetric	—	—

Note that band N extends from 0.3×10^N to 3×10^N cycles; thus band 4 designates the frequency range 0.3×10^4 to 3×10^4 cycles. The upper limit is included in each band; the lower limit is excluded.

Description of bands by means of adjectives is arbitrary and the CCIR recommends that it be discontinued.

The designation ELF, *extremely low frequency*, has recently been proposed for the band extending from 3 kilocycles down to 1 cycle per second. These frequencies have been used for years in the study of lightning and associated phenomena and may be useful in communicating with spacecraft.

The frequency bands used by **radar** (radar frequency bands) were first designated by letters for military secrecy. Those designations were:

Frequency band	Approximate frequency range, gigacycles	Approximate wavelength range, centimeters
P-band..........	0.225 to 0.39	140 to 76.9
L-band..........	0.39 to 1.55	76.9 to 19.3
S-band..........	1.55 to 5.20	19.3 to 5.77
X-band..........	5.20 to 10.90	5.77 to 2.75
K-band..........	10.90 to 36.00	2.75 to 0.834
Q-band..........	36.00 to 46.00	0.834 to 0.652
V-band..........	46.00 to 56.00	0.652 to 0.536

The C-band, 3.9 to 6.2 gigacycles, overlaps the S- and X-bands. These letter designations have no official sanction.

frequency bias. A constant **frequency** purposely added to the frequency of a signal to prevent the signal frequency from going to zero.

frequency channel. **1.** The band of **frequencies** which must be handled by a **carrier** system to transmit a specific quantity of information. **2.** A band of radio frequencies within which a station must maintain its modulated **carrier frequency** to prevent interference with stations on adjacent channels. **3.** Any **circuit** over which telephone, telegraph, or other signals may be sent by an electric current.

frequency departure. The amount of variation of a **carrier frequency** or center frequency from its assigned value.

The use of the term *frequency deviation* in this sense should be discouraged.

frequency deviation. See **frequency departure,** note.

frequency equation. An equation relating **phase speed** to **wavelength** and to the physical parameters of the system in a linear oscillation. Also called *dispersion equation.*

Mathematically, the frequency equation is the result of substituting a simple harmonic solution in the homogenous differential equations of motion and the homogeneous boundary conditions. The frequency equation thus describes the **free waves** of the system. See **group velocity.**

frequency modulation (*abbr* **FM**). **Angle modulation** of a sine-wave **carrier** in which the instantaneous frequency of the modulated wave differs from the carrier frequency by an

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amount proportional to the instantaneous value of the modulating wave. Compare **pulse modulation, amplitude modulation, phase modulation, intensity modulation.**

Combinations of phase and frequency modulation are commonly referred to as *frequency modulation.*

frequency offset transponder. A **transponder** which changes the signal **frequency** by a fixed amount before retransmission.

frequency response. **1.** The portion of the **frequency spectrum** which can be sensed by a device within specified limits of amplitude error. **2.** Response of a system as a function of the frequency of **excitation.**

frequency-shift keying (*abbr* **FSK**). That form of **frequency modulation** in which the modulating wave shifts the output frequency between predetermined values, and the output wave is **coherent** with no phase discontinuity.

frequency swing. In frequency modulation, the peak difference between the maximum and minimum values of the instantaneous **frequency.**

frequency tolerance. The extent to which a **carrier frequency** (or when a carrier is not present, a frequency coinciding with the center of an emission **bandwidth**) is permitted to depart, solely because of frequency instability, from the authorized carrier frequency (or when a carrier is not present from the assigned frequency).

Fresnel region. The region between the **antenna** and the **Fraunhofer region.**

If the antenna has a well-defined aperture a in a given aspect, the Fresnel region in that aspect is commonly taken to extend a distance $2a^2/\lambda$ in that aspect, λ being the wavelength.

Fresnel zone. Any one of the array of concentric surfaces in space between transmitter and receiver (or between radar **antenna** and **target**) over which the increase in distance over the straight line path is equal to some multiple of one-half wavelength. Also called *half-period zone.* See **interference region.**

Outside of rather unusual multipath transmission of radio energy in the free atmosphere, Fresnel zones are of importance primarily in studying the interference lobes produced by the interaction of a direct and a surface-reflected wave. Thus, for a given path, reflected radio energy arriving at the receiver from any point along any of the surface Fresnel zones will be some multiple of 180° out of phase with the direct wave, thereby producing destructive or constructive interference as the multiple is odd or even, respectively.

friction layer = planetary boundary layer.

fringe region. The upper portion of the **exosphere,** where the **cone of escape** equals or exceeds 180°. In this region the individual atoms have so little chance of collision that they essentially travel in free **orbits,** subject to the earth's gravitation, at speeds imparted by the last collision. Also called *spray region.* See **escape velocity.**

frit. A powdered ceramic prepared by fusing a physical mixture of oxides into a uniform melt, which is then quenched and milled into a fine, homogeneous powder.

frost point. See **dew point,** note.

Froude number (*symbol* N_{Fr}). The nondimensional ratio of the inertial **force** to the force of **gravity** for a given fluid flow; the reciprocal of the **Reech number.** It may be given as

$$N_{Fr} = v^2/lg$$

where v is a characteristic velocity; l a characteristic length; and g is the acceleration of gravity, or it may be given as the square root of this number.

frozen flow. Flow in which gas composition is invariant throughout the **flow field.**

frozen-in field. **1.** A **magnetohydrodynamic field** in a medium of negligible electrical resistance, in which the motion of the material is along the lines of magnetic force, which are thereby constant or *frozen.* **2.** The entrapment of **magnetic field** lines by a perfectly conducting fluid.

If a magnetic field is somehow established in a fluid with infinite conductivity, a motion of the fluid will carry the field lines and hence the field energy with it. If the fluid is compressed, the field will be compressed and if turbulence occurs in the fluid, the field will become badly twisted.

frustration threshold. The point at which an individual feels or shows frustration over inability to achieve an objective.

F-scan = F-display.

F-scope = F-display.

FSK (*abbr*) = ***f*****requency-*****s*****hift *****k*****eying.**

F_2-layer. Also called *Appleton layer.* See **ionosphere.**

fuel. Any substance used to produce heat, either by chemical or **nuclear** reaction, as used, e.g., in a **heat engine.** See **rocket propellant.**

With a liquid-propellant rocket engine, *fuel* is ordinarily distinguished from *oxidizer* where these are separate.

fuel cell. **1.** A fuel tank, especially one of a number of fuel tanks, as in an airplane's wing; also, a compartment within a fuel tank. **2.** A device which converts chemical energy directly into electrical energy but differing from a storage battery in that the reacting chemicals are supplied continuously as needed to meet output requirements.

fuel consumption. The using of **fuel** by an engine or power plant; the rate of this consumption, measured, e.g., in gallons or pounds per minute.

fuel cooled. Cooled by **fuel.** Said of a rocket engine, an oil cooler, etc. See **regenerative cooling.**

fuel shutoff. The action of shutting off the flow of liquid **fuel** into a **combustion chamber** or of stopping the combustion of a solid fuel; the event or time marking this action. Compare **cutoff.**

fugacity (*symbol f*). In thermodynamics, a measure of the tendency of a substance to escape by some chemical process from the phase in which it exists.

full moon. The moon at **opposition,** with a **phase angle** of 0°, when it appears as a round disk to an observer on the earth because the illuminated side is toward him. See **phases of the moon.**

full pressure suit. A suit which completely encloses the body and in which a gas pressure, sufficiently above **ambient pressure** for maintenance of function, may be sustained.

fully ionized plasma. The state of a **plasma** where all the neutral particles have lost at least one **electron.**

In the case of hydrogen atoms which have only one electron, no further ionization or excitation is possible when the plasma is fully ionized. For helium and all the heavier gas atoms, there are many bound electrons, each succeeding one requiring more energy to be stripped away from its atom. Therefore, in a fully ionized plasma of these gases, the ions can be further excited and multiply in an ionized state.

function. A **magnitude** so related to another magnitude that for any value of one there is a corresponding value of the other.

For instance, the area of a circle is a function of its radius. The radius is also a function of the area.

functional reserves. The ability of the body to accomplish additional muscular or other activity and useful work beyond the normal level of activity of an individual.

function table. 1. A mathematical chart which lists the values of a dependent quantity in relation to **independent variables. 2.** A routine by which a computer can determine the value of a dependent quantity from the values of independent variables. **3.** A device or circuit which translates information from one representation to another.

fundamental circle = primary great circle.

fundamental frequency. 1. Of a periodic quantity, the lowest component **frequency** of a **sinusoidal** quantity which has the same **period** as the periodic quantity. **2.** Of an oscillating system, the lowest **natural frequency.**

The normal mode of vibration associated with this frequency is known as the *fundamental mode.*

3. The reciprocal of the **period of a wave.**

fundamental mode of vibration. Of a mechanical system, the **mode** having the lowest **natural frequency.**

fundamental star places. The apparent **right ascensions** and **declinations** of 1535 standard comparison stars obtained by leading observatories and published annually under the auspices of the International Astronomical Union.

fused ceramic. A **ceramic** body or coating prepared by heating ceramic powders above the melting point, then cooling to form a coherent mass or film.

fusee. An **igniter** squib for a rocket.

fusion. The combining of atoms and consequent release of energy.

fusion power density. The **power** generated per unit volume in a controlled **thermonuclear plasma.**

Using a deuterium reaction at a density of 10^{16} particles per cubic centimeter and a temperature of 60,000 volts, the power density is about 1000 watts per cubic centimeter. The energy comes off as kinetic energy of the reaction products.

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G

g or G. An acceleration equal to the **acceleration of gravity,** 980.665 centimeter-second-squared, approximately 32.2 feet per second per second at sea level; used as a unit of stress measurement for bodies undergoing acceleration. See **acceleration of gravity; gravity.**

gage pressure. In engineering literature, a term used to indicate the difference between **atmospheric pressure** and **absolute pressure,** as read from a **differential manometer.**

gain. 1. A general term used to denote an increase in **signal power** in transmission from one point to another. Gain is usually expressed in decibels and is widely used to denote **transducer gain.** 2. An increase or amplification. In radar there are two general usages of the term: (a) antenna gain, or gain factor, is the ratio of the power transmitted along the beam axis to that of an **isotropic radiator** transmitting the same total power; (b) receiver gain. or video gain, is the amplification given a signal by the receiver. See **height gain.**

gain factor. See **gain,** sense **2(a).**

gal. (From *Galileo*). A unit of **acceleration** equal to 1 centimeter per second per second, or 1000 milligals.

The gal and milligal are used in measuring the **acceleration of gravity.**

galactic. 1. Pertaining to our **galaxy,** the Milky Way. 2. Pertaining to the **galactic system of coordinates,** as *galactic latitude.*

galactic circle = **galactic equator.** See **galactic system of coordinates.**

galactic equator. See **galactic system of coordinates.**

galactic pole. See **galactic system of coordinates.**

galactic radio waves. Radio waves emanating from our **galaxy.** See **cosmic radio waves.**

galactic system of coordinates. An astronomical **coordinate system** using latitude measured north and south from the galactic equator and longitude measured in the sense of increasing **right ascension** from 0° to 360°. See **coordinate.** table.

Galactic latitude is designated b, galactic longitude ℓ. The reference points for galactic coordinates were changed by action of the International Astronomical Union in 1958. The new values are: the north galactic pole lies in the direction right ascension = 12 hours 49 minutes, declination = 27.4° N (equinox 1950); the new zero of longitude is the great semicircle originating at the new north galactic pole at the position angle θ = 123° with respect to the equatorial pole for 1950.

galaxy. A vast assemblage of stars, nebulae, etc., composing an island universe separated from other such assemblages by great distances.

The sun and its family of planets is part of a galaxy commonly called the *Milky Way.* The nearest galaxy to the Milky Way is the spiral galaxy *Andromeda* at a distance of approximately 800,000 light years.

gamma photon = **gamma ray.**

gamma radiation = **gamma ray.**

gamma ray. A quantum of **electromagnetic radiation** emitted by a **nucleus,** each such photon being emitted as the result of a quantum transition between two energy levels of the nucleus. Gamma rays have energies usually between 10 thousand electron volts and 10 million electron volts with correspondingly short wavelengths and high frequencies. Also called *gamma radiation.*

X-rays occur in the same energy range as gamma rays but are of nonnuclear origin.

In atmospheric electricity, gamma rays are of some importance in contributing to atmospheric ionization, along with alpha particles and beta particles. Gamma-ray photons have much greater penetration ranges than do alpha and beta particles, often amounting to distances of the order of a hundred meters in air at sea level. These high-energy photons may initiate their ionizing action by ejecting **photoelectrons** from neutral atoms or molecules of the air, by ejecting electrons by the **Compton effect.** or (for gamma photons with energies above a few million electron volts) by pair production in which an electron and a positron are created.

gantry. A frame structure that spans over something, as an elevated platform that runs astride a work area, supported by wheels on each side; short for *gantry crane* or *gantry scaffold.*

gantry crane. A large crane mounted on a platform that usually runs back and forth on parallel tracks astride the work area. Often shortened to *gantry.*

gantry scaffold. A massive scaffolding structure mounted on a bridge or platform supported by a pair of towers or trestles that normally run back and forth on parallel tracks, used to assemble and service a large **rocket** as the rocket rests on its launching pad. Often shortened to *gantry.*

This structure is a latticed arrangement of girders, tubing, platforms, cranes, elevators, instruments, wiring, floodlights, cables, and ladders—all used to attend the **rocket.**

Ganymede. A **satellite** of Jupiter orbiting at a mean distance of 1,071,000 kilometers. Also called *Jupiter III.*

garbage. Miscellaneous objects in **orbit,** usually material ejected or broken away from a **launch vehicle** or **satellite.**

gas. The state of matter in which the **molecules** are practically unrestricted by intermolecular forces so that the molecules are free to occupy any space within an enclosure.

In vacuum technology the word *gas* has been loosely applied to the noncondensable gas and vapor within a **vacuum system.**

gas cap. The gas immediately in front of a body as it travels through the atmosphere.

This gas is compressed and heated. If the speed is sufficiently high, the gas becomes incandescent; it is to this condition that the term is usually applied, as in the *gas cap* of a **meteor.**

gas constant (*symbol* R, R^*, R_0). The constant factor in the **equation of state** for perfect gases. The universal gas constant is

$$R_0 = 8.3143 \text{ joules/°K-mol}$$

The gas constant for a particular gas, specific gas constant,

$$r = R/m$$

where m is the molecular weight of the gas. See **Boltzmann constant.**

gas constant per molecule = **Boltzmann constant.**

gaseous discharge = **electric discharge.**

gaseous electric discharge = **electric discharge.**

gaseous electronics. The study of the conduction of electricity through gases, involving study of the **Townsend, glow,** and **arc discharges,** and all the collision phenomena on an atomic scale. Formerly called *gaseous discharges.*

gas laws. The thermodynamic laws applying to perfect gases: **Boyle-Mariotte law, Charles-Gay-Lussac law, Dalton law, equation of state.** Also called *perfect-gas laws, ideal-gas laws.*

gas scrubbing. The contacting of a gaseous mixture with a liquid for the purpose of removing gaseous contaminants or entrained liquids or solids.

gas turbine. 1. A **turbine** rotated by expanding gases, as in a **turbojet engine** or in a turbosupercharger. **2.** A **gas-turbine engine.**

gas-turbine engine. An engine incorporating as its chief element a **turbine** rotated by expanding gases. In its most usual form, it consists essentially of a rotary air **compressor** with an air intake, one or more **combustion chambers,** a turbine, and an exhaust outlet.

gate. 1. To control passage of a **signal** as in the circuits of a **computer. 2.** A **circuit** having an output and inputs so designed that the output is energized only when a definite set of input conditions are met. In computers, called *AND-gate.*

gating. The process of selecting those portions of a **wave** which exist during one or more selected time intervals or which have magnitudes between selected limits.

gauss. A unit of **magnetic induction** (or **magnetic flux density**) equal to 1 dyne per unit cgs magnetic pole.

Prior to 1932, the gauss was used both as a unit of magnetic induction and as a unit of **magnetic field intensity,** but the latter quantity is now measured in *oersteds.*

Gaussian constant (*symbol* k). Originally used in astronomical calculations as $k = \sqrt{G}$, where G is the **constant of gravitation.** k is now defined as exactly 0.01720209895 radians. Also called *Gaussian gravitation constant.* See **astronomical unit.**

Gaussian distribution = **normal distribution.**

Gaussian gravitation constant = **Gaussian constant.**

Gaussian noise = **random noise.**

Gauss theorem = **divergence theorem.**

Gay-Lussac law = **Charles-Gay-Lussac law.**

GCA (*abbr*) = **ground-controlled approach.**

GCI (*abbr*) = **ground-controlled intercept.**

G-display. In radar, a rectangular **display** in which a **target** appears as a laterally centralized **blip** when the radar antenna is aimed at it in azimuth and **wings** appear to grow on the blip as the distance to the target is diminished. Horizontal and vertical aiming errors are respectively indicated by horizontal and vertical displacement of the blip. Also called *G-scan, G-scope, G-indicator.*

gee. A suffix meaning earth, as in *perigee, apogee.* See **perigee,** note.

gegenschein. A round or elongated spot of light in the sky at a point 180° from the sun. Also called *counterglow, zodiacal counterglow,* Compare **zodiacal light.**

Geiger counter. An instrument for detecting and measuring radioactivity. In full, *Geiger-Muller counter.*

This counter, essentially a thin-walled gas-filled metallic tube with a needle electrode projected within,

detects the radiating particle indirectly. The particle penetrates the thin wall and ionizes the gas; a current is momentarily set up, which is detectable and measureable. Compare **scintillation counter.**

Geiger-Muller counter. Full term for *Geiger counter.*

Gem, Gemi. International Astronomical Union abbreviations for *Gemini.* See **constellation.**

Gemini (*abbr* **Gem, Gemi**). See **constellation.**

general circulation = planetary circulation.

generalized coordinates. Any set of **coordinates** specifying the state of the system under consideration. Usually employed in problems involving a finite number of **degrees of freedom,** the generalized coordinates are chosen so as to take advantage of the constraints of the system in reducing the total number of coordinates. Also called *Lagrangian coordinates.*

generalized transmission function. In atmospheric-radiation theory, a set of values, variable with wavelength, each one of which represents an average **transmission coefficient** for a small wavelength interval and for a specified optical path through the absorbing gas in question. See **universal transmission function.**

general perturbations. In orbital determinations, a method of calculating perturbative effects by expanding and integrating in series. See **perturbation.**

general precession. The resultant motion of the components causing **precession of the equinoxes.** The general precession is westward along the ecliptic at the rate of about 50.3 seconds of arc per year.

The effect of the sun and moon, called *lunisolar precession,* is to produce a westward motion of the equinoxes along the ecliptic. The effect of other planets, called *planetary precession,* tends to produce a much smaller motion eastward along the ecliptic. The component of general precession along the celestial equator, called *precession in right ascension,* is about 46.1 seconds of arc per year; and the component along a celestial meridian, called *precession in declination,* is about 20.0 seconds of arc per year. See **astronomical constants.**

generation. In any technical or technological development, as of a missile, jet engine, or the like, a stage or period that is marked by features or performances not marked, or existent, in a previous period of development or production, as in *the first generation of rockets using liquid propellants.*

genetic effect of radiation. Inheritable changes, chiefly mutations, produced in living organisms by the absorption of **ionizing radiations.** On the basis of present knowledge these effects are purely additive, and there is no recovery.

geo. A prefix meaning earth, as in *geology, geophysics.*

Some writers use the established terms such as *geology* to refer to the same concept on other bodies of the solar system, as *the geology of Mars,* rather than *areology* or *marsology, geology of the Moon,* rather than *selenology.*

geocentric. Relative to the earth as a center; measured from the center of the earth.

geocentric diameter. The diameter of a **celestial body** measured in seconds of arc as viewed from the earth's center.

geocentric latitude. Of a position in the earth's surface; the angle between a line to the center of the earth and the plane of the equator.

Because the earth is approximately an oblate spheroid, rather than a true sphere, this differs from geographic latitude, the maximum difference being 11.6 minutes of arc at latitude 45°.

geocentric parallax. The difference in the apparent direction or position of a **celestial body** measured in seconds of arc, as observed from the center of the earth and a point on its surface. See **parallax.**

geocorona. **1.** The shell of hydrogen surrounding the earth at the limit of the atmosphere.

In Shlovsky's system of nomenclature, the geocorona includes the metasphere, the outer, fully ionized zone, and the protosphere, the inner zone.

2. = Van Allen radiation belts.

The use of *geocorona* in sense **2** should be discouraged, since it conflicts with the relatively well-established usage in sense **1.**

geodesic. **1.** Of or pertaining to geodesy; geodetic. **2.** A geodesic line.

geodesic line. The shortest line on a mathematically derived surface, between two points on the surface. Also called *geodesic.*

A geodesic line on the spheroidal earth is called a *geodetic line.*

geodesy. The science which deals mathematically with the size and shape of the earth, and the earth's external **gravity** field, and with surveys of such precision that overall size and shape of the earth must be taken into consideration.

geodetic. Of or pertaining to **geodesy;** geodesic.

geodetic coordinates. Quantities which define the position of a point on the **spheroid** of reference with respect to the planes of the geodetic equator and of a reference meridian. Compare **geographic coordinates.**

geodetic datum. A datum consisting of five quantities, the latitude and longitude and elevation above the reference **spheroid** of an initial point, a line from this point, and two constants which define the reference **spheroid. Azimuth** or orientation of the line, given the

longitude, is determined by astronomic observations. Alternatively, the datum may be considered as three rectangular coordinates fixing the origin of a **coordinate system** whose orientation is determined by the fixed stars, and the reference spheroid is an arbitrary coordinate surface of an orbiting ellipsoidal coordinate system.

A geodetic datum forms the basis for the computation of horizontal control surveys in which the curvature of the earth is considered.

geodetic equator. That **great circle** midway between the poles of revolution of the earth, connecting points of 0° geodetic latitude. See **astronomical equator.**

geodetic latitude. Angular distance between the plane of the **equator** and a normal to the **spheroid.** It is the **astronomical latitude** corrected for the meridional component of the **deflection of the vertical.** Also called *geographic latitude, topographical latitude.*

This is the latitude used for charts.

geodetic line. A **geodesic line** on the spheroidal earth. Also called *geodesic.* Compare **geodesic line.**

geodetic longitude. The angle between the plane of the reference **meridian** and the plane through the polar axis and the normal to the **spheroid.** It is the **astronomical longitude** corrected for the prime vertical component of the **deflection of the vertical** divided by the cosine of the **latitude.** Also called *geographic longitude.*

This is the longitude used for charts.

geodetic meridian. A line connecting points of equal **geodetic longitude.** Also called *geographic meridian.* See **astronomical meridian.**

geodetic parallel. A line connecting points of equal **geodetic latitude.** Also called *geographic parallel.* See **astronomical parallel.**

geodetic position. A position of a point on the surface of the earth expressed in terms of **geodetic latitude** and **geodetic longitude.**

A geodetic position implies an adopted geodetic **datum,** which must be stated for a complete record of the position.

geodetic survey. 1. A survey which takes into account the size and shape of the earth. **2.** An organization engaged in making geodetic surveys, sense **1.**

geodynamic height = dynamic height.

geodynamic meter = dynamic meter. See **dynamic height.**

geographical coordinates = geographic coordinates.

geographical mile. The length of 1 minute of arc of the equator, or 6087.08 feet.

geographical pole. Either of the two points of intersection of the surface of the earth with its axis of rotation where all **meridians** meet, labeled N or S to indicate whether the *north* geographical pole or the *south* geographical pole.

geographical position. 1. That point on the earth at which a given **celestial body** is in the **zenith** of a specified time.

The geographical position of the sun is also called the *subsolar point,* of the moon the *sublunar point,* and of a star the *substellar* or *subastral point.*

2. Any position on the earth defined by means of its **geographic coordinates,** either astronomical or geodetic.

geographic coordinates. Coordinates defining a point on the surface of the earth, usually **latitude** and **longitude.** Also called *terrestrial coordinates, geographical coordinates.* See **coordinate,** table, for relationship between **geographic coordinates** and **celestial coordinates.**

Geographic coordinates can refer to either astronomical or geodetic coordinates.

geographic latitude = geodetic latitude.

geographic longitude = geodetic longitude.

geoid. The figure of the earth as defined by the **geopotential surface** which most nearly coincides with mean sea level over the entire surface of the earth.

Because of variations in the direction of gravity, to which it is everywhere perpendicular, the geoid is not quite an **ellipsoid of revolution,** the sea-level surface being higher under mountainous areas. Compare **equilibrium spheroid, geosphere.**

geoidal horizon. That circle of the **celestial sphere** formed by the intersection of the celestial sphere and a plane through a point on the **geoid** perpendicular to the zenith-nadir line. See **horizon.**

geomagnetic. Of or pertaining to **geomagnetism.**

geomagnetic coordinates. A system of **spherical coordinates** based on the best fit of a centered **dipole** to the actual **magnetic field** of the earth.

geomagnetic equator. The terrestrial **great circle** everywhere 90° from the **geomagnetic** poles.

Geomagnetic equator should not be confused with magnetic equator, the line connecting all points of zero magnetic dip. Compare **aclinic line.**

geomagnetic latitude. Angular distance from the **geomagnetic equator,** measured northward or southward through 90° and labeled N or S to indicate the direction of measurement. Also erroneously called *magnetic latitude.*

Geomagnetic latitude should not be confused with magnetic latitude, the **magnetic dip.**
Phenomena closely related to the earth's magnetic field are often plotted according to geomagnetic latitude rather than geographic latitude.

geomagnetic meridian. **1.** The meridional lines of a **geomagnetic** coordinate system. **2.** = **magnetic meridian.**

geomagnetic pole. Either of two antipodal points marking the intersection of the earth's surface with the extended axis of a **dipole** assumed to be located at the center of the earth and approximating the source of the actual **magnetic field** of the earth.

That pole in the Northern Hemisphere (latitude, 78½° N; longitude, 69° W) is designated *north geomagnetic pole*, and that pole in the Southern Hemisphere (latitude, 78½° S, longitude, 111° E) is designated *south geomagnetic pole.* The great circle midway between these poles is called *geomagnetic equator*. The expression geomagnetic pole should not be confused with magnetic pole, which relates to the actual magnetic field of the earth. See **geomagnetic latitude.**

geomagnetic storm = **magnetic storm.**

geomagnetism. **1.** The **magnetic** phenomena, collectively considered, exhibited by the earth and its atmosphere and by extension the magnetic phenomena in interplanetary **space.** **2.** The study of the **magnetic field** of the earth. Also called *terrestrial magnetism.*

geometrical horizon. See **horizon.**

geometric chord. See **chord,** note.

geometric dilution of precision (*abbr* **GDOP**). As applied to a **trajectory measuring system,** the increase in error of calculated space position which is caused by the location of the measured position relative to the system.

This is an increase which is caused solely by the geometry of the problem and assumes that all basic measurements maintain a constant accuracy.

geometric mean. A measure of central position. The geometric mean of n quantities equals the nth root of the product of the quantities.

geometric position = **true position.**

geophysics. The physics of the earth and its environment, i.e., earth, air, and (by extension) space.

Classically, geophysics is concerned with the nature of and physical occurrences at and below the surface of the earth including, therefore, geology, oceanography, geodesy, seismology, hydrology, etc. The trend is to extend the scope of geophysics to include meteorology, geomagnetism, astrophysics, and other sciences concerned with the physical nature of the universe.

geopotential. The **potential energy** of a unit mass relative to sea level, numerically equal to the work that would be done in lifting the unit mass from sea level to the height at which the mass is located; commonly expressed in terms of **dynamic height** or **geopotential height.** Compare **gravitational potential.**

The geopotential Φ at height Z is given mathematically by the expression,

$$\Phi = \int_0^Z g dZ$$

where g is the acceleration of gravity.

geopotential height. The height of a given point in the atmosphere in units proportional to the potential energy of unit mass (**geopotential**) at this height, relative to sea level.

The relation, in the cgs system, between the geopotential height H and the geometric height Z is

$$H = \frac{1}{980} \int_0^Z g dZ$$

where g is the acceleration of gravity, so that the two heights are numerically interchangeable for most meteorological purposes. Also, 1 geopotential meter is equal to 0.98 **dynamic meter.** See **dynamic height.**
At the present time, the geopotential height unit is used for all aerological reports, by convention of the World Meteorological Organization.

geopotential meter. A unit of length used in measuring **geopotential height;** 1 geopotential meter is equal to 0.98 **dynamic meter.** See **dynamic height.**

geopotential surface. A surface of constant geopotential, i.e., a surface along which a particle of matter could move without undergoing any changes in its **potential energy.** Also called *equigeopotential surface, level surface.*

Geopotential surfaces almost coincide with surfaces of constant geometric height. Because of the poleward increase of the acceleration of gravity along a constant geometric-height surface, a given geopotential surface has a smaller geometric-height over the poles than over the equator. See **potential, geopotential height, dynamic height.**

georef (*abbr*) = **World *Ge*ographic *Ref*erence System.** Pronounced as a word.

geosphere. The solid and liquid portions of the earth; the **lithosphere** plus the **hydrosphere.** Compare **geoid, equilibrium spheroid.**

Above the geosphere lies the atmosphere and at the interface between these two regions is found almost all of the biosphere, or zone of life.

geostrophic wind. That horizontal wind velocity for which the **coriolis acceleration** exactly balances the horizontal pressure force. Compare **gradient wind.**

geostrophic wind level. The lowest level at which the wind becomes **geostrophic** in the theory of the **Ekman spiral,** proportional to

$$\sqrt{v/\sin\varphi}$$

where v is the kinematic eddy viscosity and φ the latitude. Also called *gradient wind level.*

In practice it is observed that the geostrophic wind level is between 1.2 and 1.6 kilometers, and it is assumed that this marks the upper limit of frictional influence of the earth's surface.

The geostrophic wind level may be considered to be the top of the **Ekman layer** and **planetary boundary layer**, i.e., the base of the **free atmosphere**.

get. To remove gas from a vacuum system by **sorption.**

getter. **1.** A material which is included in a vacuum system or device for removing gas by **sorption.** **2.** To remove gas by **sorption.** Also called *get.*

G-force. An **inertial force** usually expressed in multiples of terrestrial **gravity.**

GHA (*abbr*) = ***Greenwich hour angle.***

giant planets. The **planets** Jupiter, Saturn, Uranus, and Neptune. Also called *Jovian planets.*

gibbous. Bounded by convex curves.

The term is used particularly in reference to the moon when it is between first quarter and full or between full and last quarter, or to other celestial bodies when they present a similar appearance. See **phases of the moon.**

Gibbs free energy = **Gibbs function.**

Gibbs function. A mathematically defined **thermodynamic function of state,** which is constant during a reversible isobaric-isothermal process. Also called *Gibbs free energy, thermodynamic potential.* Compare **Helmholtz function.**

In symbols the specific Gibbs function g is

$$g = h - Ts$$

where h is specific enthalpy; T is Kelvin temperature; and s is specific entropy. By use of the first law of thermodynamics for reversible processes,

$$dg = -s\,dT + dp$$

giga (*abbr* **G**). A prefix meaning multiplied by 10^9.

gimbal. **1.** A device with two mutually perpendicular and intersecting **axes of rotation,** thus giving free angular movement in two directions, on which an engine or other object may be mounted. **2.** In a **gyro,** a support which provides the **spin axis** with a **degree of freedom.** **3.** To move a **reaction engine** about on a gimbal so as to obtain pitching and yawing **correction moments.** **4.** To mount something on a gimbal.

gimbaled motor. A **rocket engine** mounted on a **gimbal.**

gimbal freedom. In a **gyro,** the maximum angular displacement about the output axis of a gimbal.

It is expressed in degrees of output angle or in equivalent angular input.

gimbal lock. A condition of a two-degree-of-freedom **gyro** wherein the alinement of the spin axis with an **axis of freedom** deprives the gyro of a **degree of freedom,** and therefore of its useful properties.

G-indicator. **1. G-display.** **2.** A display that shows the amount of **inertial force** acting on a body.

Giorgi system = **MKSA system.**

G-layer. A layer of **free electrons** in the ionosphere which is occasionally observed above the F_2-layer. See **ionosphere.**

glide. **1.** A controlled descent by a heavier-than-air aeronautical vehicle under little or no engine thrust in which forward motion is maintained by **gravity** and vertical descent is controlled by **lift** forces. **2.** A descending flight path of a glide, sense **1,** as, a shallow *glide.* **3.** To descend in a glide, sense **1.**

glide angle = **gliding angle.**

glide path. **1.** The **flight path** of an aeronautical vehicle in a **glide,** seen from the side. **2.** The path used by an aircraft or spacecraft in approach procedure and which is generated by an instrument-landing facility.

glider. **1.** A fixed-wing aircraft specially designed to **glide,** or to glide and **soar.** This kind of aircraft ordinarily has no powerplant. **2.** See **hypersonic glider.**

glide ratio. The ratio of the horizontal distance traveled to the vertical distance descended in a **glide.** Also called *gliding ratio.*

glide slope. **1.** An inclined surface which includes a **glide path** and which is generated by an instrument-landing facility. **2.** = **slope angle.** **3.** = **gliding angle.**

gliding angle. The angle between the horizontal and the **glide path** of an aircraft. Also called *glide angle* or *glide slope.*

gliding ratio = **glide ratio.**

global radiation. The total of **direct solar radiation** and **diffuse sky radiation** received by a unit horizontal surface.

Global radiation is measured by **pyranometers.**

global velocities. The range of velocities, slightly less than **circular velocity,** that permit sustained flight once around the earth in equilibrium glide. Compare **orbital velocity.**

globe lightning = **ball lightning.**

glow discharge. Any **electrical discharge** which produces **luminosity.**

Thus **corona discharge** is a glow discharge, but **point discharge** is not. Relatively high electric field strengths are required for glow discharges, for the density of radiatively recombining gas atoms and molecules must be high. See **gaseous electronics.**

G-meter. A meter that indicates **acceleration.**

GMT (*abbr*) = ***Greenwich mean time.***

gnotobiotics. The study of germ-free animals.

goniometer. An instrument for measuring **angles.**

gox. Gaseous oxygen.

* GIMBALLING - movement of engines to redirect thrust + help steer (Space Shuttle) during launch.

gradient. **1.** The space rate of decrease of a function. Of a function in three space dimensions, the **vector** normal to surfaces of constant value of the function and directed toward decreasing values, with magnitude equal to the rate of decrease of the function in this direction. The gradient of a function f is denoted by $-\nabla f$ (without the minus sign in the older literature), and is itself a function of both space and time. The ascendent is the negative of the gradient. See **del-operator.** **2.** Often loosely used to denote the **magnitude** of the gradient or ascendant. **3.** Either the rate of change of a quantity (as temperature, pressure, etc.) or a diagram or curve representing this.

gradient wind. Any horizontal wind velocity tangent to the contour line of a constant pressure surface or an isobar of a geopotential surface. At such points the **coriolis acceleration** and the **centripetal acceleration** together exactly balance the horizontal pressure force. Compare **geostrophic wind.**

grain. **1.** An elongated molding or extrusion of **solid propellant** for a **rocket,** regardless of size. **2.** In photography, a small particle of metallic silver remaining in a photographic emulsion after development and fixing. In the agglomerate, these grains form the dark area of a photographic image. **3.** An individual crystal in a polycrystalline metal or alloy.

gram. The standard of mass in the **metric system.**

gram-calorie. See **calorie.**

gram-centimeter. The **CGS** gravitation unit of work.

gram-molecule. The mass in grams of a substance numerically equal to its **molecular weight.**

granules. Small bright features of the **photosphere** of the sun, covering 50 to 60 percent of the surface. They have been likened in appearance to rice grains.

graph. A diagram indicating the relationship between two or more **variables.**

Grashof number (*symbol* N_{Gr}, G_r). A nondimensional parameter used in the theory of **heat transfer,** defined by

$$N_{Gr} = l^3 g\ [(T_1 - T_0)/v^2 T_0]$$

where l is a representative length; T_1 and T_0 are representative temperatures; g is the acceleration of gravity; and v is the kinematic viscosity.

The Grashof number is associated with the **Reynolds number** and the **Prandtl number** in the study of **convection.**

grass. **1.** Sharp, closely spaced discontinuities in the trace of a **cathode-ray tube,** produced by random interference; so named because of their resemblance to blades of lawn grass. **2.** In radar, a descriptive colloquialism used to refer to the indication of noise on an 'A' or similar type of **display.** See **noise.**

graticule. **1.** The network of lines representing **parallels** and **meridians** on a map, chart, or plotting sheet. See **grid.** **2.** A scale at the focal plane of an optical instrument to aid in the measurement of objects. See **reticle.**

graviceptor = **gravireceptor.**

gravireceptors. Highly specialized nerve endings and receptor organs located in skeletal muscles, tendons, joints, and in the inner ear which furnish information to the brain with respect to body position, equilibrium, and the direction of gravitational forces. See **gravitation.**

gravitation. The **acceleration** produced by the mutual attraction of two masses, directed along the line joining their centers of masses, and of magnitude inversely proportional to the square of the distance between the two centers of mass.

This acceleration on a unit mass has the magnitude $G(m/r^2)$, where m is the mass of the attracting body, r is the distance between the centers of mass, and G is the gravitational constant equal to $6.670 \pm 0.005 \times 10^{-8}$ cm²/gram sec².

In the case of masses in the earth's gravitational field, m is the mass of the earth, equal to 5.975×10^{27} grams. However, the rotation of the earth and atmosphere modifies this field to produce the field of **gravity.**

gravitational. Pertaining to **gravitation.**

gravitational constant (*symbol* G). The coefficient of proportionality in **Newton law of gravitation**

$$G = 6.670 \pm 0.005 \times 10^{-8} \text{ dyne-centimeter squared per gram squared}$$

Also called *constant of gravitation, Newtonian universal constant of gravitation.*

In celestial mechanics, G may be used as a symbol with units unspecified or in a particular problem may be made equal to 1 or $4\pi^2$ by the choice of units for other parameters in the particular problem.

gravitational potential. **1.** The **potential** associated with the force of **gravitation** arising from the attraction between mass points, e.g., the earth's center and a particle in space.

The gravitational potential, associated with the force of gravitation, should not be confused with the **geopotential** associated with the force of **gravity.** The latter is equal to the former plus the centrifugal force due to the earth's rotation. The potentials of the three forces are related in the same manner.

2. At any point, the **work** needed to remove an object from that point to infinity.

gravitational red shift. See **red shift,** note.

gravitational tide. An **atmospheric tide** due to gravitational attraction of the sun or moon. See **thermal tide.**

The semidiurnal solar atmospheric tide is partly gravitational; the semidiurnal lunar atmospheric tide is totally gravitational.

gravitational wave = gravity wave.

gravitation constant. See **Newtonian universal constant of gravitation, Gaussian constant.**

graviton. The hypothetical elementary unit of gravitation which is equivalent to the **electron** in electromagnetic theory.

gravity. 1. Viewed from a frame of reference fixed in the earth, force imparted by the earth to a mass which is at rest relative to the earth. Since the earth is rotating, the force observed as gravity is the resultant of the force of **gravitation** and the **centrifugal force** arising from this rotation and the use of an earthbound rotating frame of reference. It is directed normal to sea level and to its geopotential surfaces. See **virtual gravity, geopotential height, standard gravity.**

The magnitude of the force of gravity at sea level decreases from the poles, where the centrifugal force is zero, to the equator, where the centrifugal force is a maximum but directed opposite to the force of gravitation. This difference is accentuated by the shape of the earth, which is nearly that of an oblate spheroid of revolution slightly depressed at the poles. Also, because of the asymmetric distribution of the mass of the earth, the force of gravity is not directed precisely toward the earth's center.

The magnitude of the force of gravity is usually called either *gravity*, *acceleration of gravity*, or *apparent gravity*.

2. = acceleration of gravity. 3. By extension, the attraction of any heavenly body for any mass; as *Martian gravity*.

gravity wave. A **wave** disturbance in a **fluid** in which buoyancy (or reduced gravity) acts as the restoring force on fluid parcels displaced from **hydrostatic equilibrium.** Also called *gravitational wave*.

gravity well. An analogy in which the **gravitational** field is considered as a deep pit out of which a space vehicle has to climb to escape from a planetary body.

gray body. A hypothetical body which absorbs some constant fraction, between zero and one, of all **electromagnetic radiation** incident upon it, which fraction is the **absorptivity** and is independent of **wavelength.** As such, a gray body represents a surface of absorptive characteristics intermediate between those of a **white body** and a **black body.** No such substances are known in nature. Also called *grey body*.

Gray code. A **binary code** in which adjacent quantities differ in one place or column only. Often used in mechanical devices.

grayout. A temporary condition in which vision is hazy, restricted, or otherwise impaired, owing to insufficient oxygen. Compare **blackout.**

great circle. The intersection of a **sphere** and a plane through its center. Also called *orthodrome*.

The intersection of a sphere and a plane which does not pass through its center is called a *small circle*.

greatest elongation. The maximum angular distance of a body of the **solar system** from the sun, as observed from the earth.

The direction of the body east or west of the sun is usually specified, as *greatest elongation west*.

Great Red Spot. An oval feature in the visible cloud surface of Jupiter, at latitude 20° to 25° S. It is about 25,000 miles long in the planet's east-west direction, and about 7000 miles wide in the north-south direction. It is often reddish in color, but may be white or grey, or nearly invisible compared to its surroundings. See **South Tropical Disturbance.**

The neighboring cloud matter seems to pass around it on the northern side, producing the so-called *Red Spot Hollow*, by which it may be detected even when the spot itself is invisible. Its rotation period averages 9 hours, 55 minutes, 38 seconds (very nearly the same as the rest of the planet), but varies enough so that through the years since its discovery in 1878 it has made more than one complete revolution with respect to the underlying planet.

great year. The period of one complete cycle of the **equinoxes** around the **ecliptic,** about 25,800 years. Also called *platonic year*. See **precession of the equinoxes.**

green flash. A brilliant green coloring of the upper edge of the sun as it appears at sunrise or disappears at sunset when there is a clear, distinct horizon.

The green flash is due to **refraction** by the atmosphere, which disperses the first (or last) spot of light into a spectrum. The green is bent more than red or yellow and hence is visible sooner at sunrise and later at sunset.

greenhouse effect. The heating effect exerted by the atmosphere upon the earth by virtue of the fact that the atmosphere (mainly, its water vapor) absorbs and reemits **infrared radiation.** In detail: the shorter wavelengths of **insolation** are transmitted rather freely through the atmosphere to be absorbed at the earth's surface. The earth then reemits this as long-wave (infrared) **terrestrial radiation,** a portion of which is absorbed by the atmosphere and again emitted (see **atmospheric radiation**). Some of this is emitted downward back to the earth's surface (**counter-radiation**).

The mean surface temperature for the entire world,

14° C, is almost 40° C higher than the mean temperature required for radiative equilibrium of a black body at the earth's mean distance from the sun. It is essential, in understanding the concept of the greenhouse effect, to note that the important additional warming is due to the counterradiation from the atmosphere. The glass panes of a greenhouse function in this manner, hence the name.

Green theorem. See **divergence theorem.**

Greenwich apparent time (*abbr* **GAT**). **Local apparent time** at the **Greenwich meridian;** the arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the Greenwich celestial meridian and the hour circle of the apparent or true sun, measured westward from the lower branch of the Greenwich celestial meridian through 24 hours; **Greenwich hour angle** of the apparent or **true sun,** expressed in time units, plus 12 hours.

Greenwich civil time (*abbr* **GCT**) = **Greenwich mean time.** (United States terminology from 1925 through 1952.)

Greenwich hour angle (*abbr* **GHA**). Angular distance west of the Greenwich **celestial meridian;** the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the Greenwich celestial meridian and the hour circle of a point on the **celestial sphere,** measured westward from the Greenwich celestial meridian through 360°; local hour angle at the Greenwich meridian.

Greenwich mean time (*abbr* **GMT**). **Local mean time** at the **Greenwich meridian;** the arc of the celestial equator, or the angle at the celestial pole, between the lower branch of the Greenwich celestial meridian and the hour circle of the mean sun, measured westward from the lower branch of the Greenwich celestial meridian through 24 hours; **Greenwich hour angle** of the **mean sun,** expressed in time units, plus 12 hours. Called *Greenwich civil time* in U.S. terminology from 1925 through 1952. Also called *universal time, Z-time.*

Mean time reckoned from the upper branch of the Greenwich meridian is called *Greenwich astronomical time.*

Greenwich meridian. The meridian through Greenwich, England, serving as the reference for Greenwich time.

The Greenwich meridian is accepted almost universally as the prime meridian, or the origin of measurement of **longitude.**

Greenwich sidereal time (*abbr* **GST**). **Local sidereal time** at the **Greenwich meridian;** the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of the Greenwich celestial meridian and the hour circle of the vernal equinox, measured westward from the upper branch of the Greenwich celestial meridian through 24 hours; **Greenwich hour angle** of the **vernal equinox,** expressed in time units.

G-region. See **ionosphere.**

Gregorian calendar. The calendar now in common use, in which each year has 365 days except leap years. See **calendar year.**

grey body = **gray body.**

grid. 1. A series of lines, usually straight and parallel, superimposed on a chart or plotting sheet to serve as a directional reference for navigation. See **graticule. 2.** Two sets of mutually perpendicular lines dividing a map or chart into squares or rectangles to permit location of any point by a system of rectangular coordinates. See **military grid, world geographic referencing system. 3.** An **electrode** with one or more openings to permit passage of **electrons** or **ions.** It usually consists of a wire mesh electrode placed between the anode and cathode of an electron tube to serve as a control of the current flowing between them. **4.** Pertaining to or measured from a reference grid, as *grid azimuth, grid latitude, grid meridian.*

grid variation. See **variation,** note.

grivation = **grid variation.**

gross thrust. The total **thrust** of a **jet engine** without deduction of the **drag** due to the momentum of the incoming air (ram drag).

The gross thrust is equal to the product of the mass rate of fluid flow and the velocity of the fluid relative to the nozzle, plus the product of the nozzle exit area and the difference between the exhaust pressure and ambient pressure.

gross weight. The total weight of an aircraft, rocket, etc., as loaded; specifically, the total weight with full crew, full tanks, payload, etc. Also called *take-off weight.* See **design gross weight.**

ground. 1. The earth's surface, especially the earth's land surface. Used in combination to form adjectives, as in *ground-to-air, ground-to-ground,* and *air-to-ground.* See **surface. 2.** The domain of nonflight operations that normally take place on the earth's surface or in a vehicle or on a platform that rests upon the surface, as in *ground support.* **3.** = electrical ground.

ground clutter = **ground return.**

ground-controlled approach (*abbr* **GCA**). A ground **radar** system providing information by which aircraft approaches may be directed via radio communications.

ground-controlled intercept (*abbr* **GCI**). A **radar** system by means of which a controller may direct an aircraft to make an interception of another aircraft.

ground-effect machine. A machine that hovers or moves just above the ground by creating a cushion of supporting air between it and the ground surface and by varying the thrust vector and magnitude to regulate direction and rate of motion.

ground environment. 1. The **environment** that surrounds and affects a system or piece of equipment while it operates on the ground. **2.** That **system** or part of a system, as of a guidance system, that functions on the ground; the aggregate of equipment, conditions, facilities, and personnel that go to make up a system, or part of a system, functioning on the ground. See **environment.**

ground-handling equipment. Equipment on the ground used to move, lift, or transport a space vehicle, a rocket, or component parts.

Such equipment includes the gantry, the transporter, and the forklift.

ground layer = surface boundary layer.

ground return. Radar **echoes** reflected from the terrain. Also called *ground clutter*, *land return.*

Echoes from the sea are called *sea clutter* or *sea return.*

ground start. An *ignition sequence* of a rocket's main stage, initiated and cycled through on the ground. Compare **air start, inflight start.**

In large rockets, the ground start may be fueled from pressurized tanks external to the rocket, permitting takeoff with the rocket's own internal propellant load intact.

ground-support equipment (*abbr* **GSE**). That equipment on the ground, including all implements, tools, and devices (mobile or fixed), required to inspect, test, adjust, calibrate, appraise, gage, measure, repair, overhaul, assemble, disassemble, transport, safeguard, record, store, or otherwise function in support of a rocket, space vehicle, or the like, either in the research and development phase or in an operational phase, or in support of the guidance system used with the missile, vehicle, or the like.

The GSE is not considered to include land or buildings; nor does it include the guidance-station equipment itself, but it does include the test and checkout equipment required for operation of the guidance-station equipment.

ground wave. A **radio wave** that is propagated over the earth and is ordinarily affected by the presence of the earth's surface and the **troposphere.** The ground wave includes all components of a radio wave over the earth except **ionospheric** and **tropospheric** waves. Compare **sky wave.**

The ground wave is refracted because of variations in the dielectric constant of the troposphere including the condition known as a **surface duct.**

group velocity. The velocity of a **wave** disturbance as a whole, i.e., of an entire group of component simple harmonic waves. The group velocity U is related to the phase speed c of the individual harmonic waves of length l by the frequency equation

$$U = c - l(dc/dl)$$

The phase speed c is thus equal to the group velocity only in the case of nondispersive waves, i.e., when $dc/dl = 0$. See **velocity of propagation.**

Gru, Grus. International Astronomical Union abbreviations for *Grus.* See **constellation.**

Grus (*abbr* **Gru, Grus**). See **constellation.**

G-scan = G-display.

G-scope = G-display.

GSE (*abbr*) = ***ground-support equipment.***

g-suit or **G-suit.** A suit that exerts pressure on the abdomen and lower parts of the body to prevent or retard the collection of blood below the chest under positive **acceleration.** Compare **pressure suit.**

g-tolerance. A tolerance in a person or other animal, or in a piece of equipment, to an **acceleration** of a particular value.

guidance. The process of directing the movements of an aeronautical vehicle or space vehicle, with particular reference to the selection of a flight path. See **control.**

In preset guidance a predetermined path is set into the guidance mechanism and not altered, in inertial guidance accelerations are measured and integrated within the craft, in command guidance the craft responds to information received from an outside source. Beam-rider guidance utilizes a beam; terrestrial-reference guidance, some influence of the earth; celestial guidance, the celestial bodies and particularly the stars; and homing guidance, information from the destination. In active homing guidance the information is in response to transmissions from the craft, in semiactive homing guidance the transmissions are from a source other than the craft, and in passive homing guidance natural radiations from the destination are utilized. Midcourse guidance extends from the end of the launching phase to an arbitrary point enroute and terminal guidance extends from this point to the destination.

guided missile. 1. Broadly, any **missile** that is subject to, or capable of, some degree of guidance or direction after having been launched, fired, or otherwise set in motion. **2.** Specifically, an unmanned, self-propelled flying vehicle (such as a pilotless aircraft or **rocket**) carrying a destructive load and capable of being directed or of directing itself after launching or take-off, responding either to ex-

ternal direction or to direction originating from devices within the missile itself. **3.** Loosely, by extension, any steerable projectile. See **ballistic missile.**

guiding center. The center point of the **Larmor orbit** of a charged particle gyrating in a magnetic field.

It is often convenient to separate the total motion of a particle into the Larmor orbit plus the motion of the guiding center. In addition to the unimpeded motion of the guiding center of a particle along the magnetic field, the presence of electric fields will displace the guiding center perpendicular to the magnetic field.

gust tunnel. A **wind tunnel** in which gusts are simulated. Specifically, a tunnel in which models are passed over a vertical jet or jets simulating gusts.

gyro. **1.** A device which utilizes the angular momentum of a spinning mass (rotor) to sense angular motion of its base about one or two axes orthogonal to the spin axis. Also called *gyroscope.*

This definition does not include more complex systems such as **stable platforms** using gyros as components.

2. Short for *directional gyro*, *gyrocompass*, etc.

gyrofrequency. The natural period of revolution of a **free electron** in the earth's **magnetic field.** See **magnetoionic theory.**

gyro horizon. An **artificial horizon** or an **attitude gyro.**

gyro pickoff. A device which produces a **signal,** generally a voltage, as a function of the angle between two **gyro** gimbals or between a **gimbal** and the base.

gyroscope = **gyro.**

gyroscopic inertia. The property of a rotor of resisting any force which tends to change its axis of rotation. See **gyro.**

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H

Hagen-Poiseuille flow = Poiseuille flow.

half life. The average time required for one half the atoms in a sample of **radioactive** element to decay.

The half life $t_{\frac{1}{2}}$ is given by

$$t_{\frac{1}{2}} = (\ln 2)/\lambda$$

where λ is the decay constant.

half-period zone = Fresnel zone.

half-power points. The points on the **radiation pattern** of an **antenna** where the transmitted power is one-half that of the maximum of the same lobe. See **half-power width.**

half-power width. In a plane containing the direction of the maximum of a lobe of the **radiation pattern** of an antenna, the full angle between the two directions in that plane in which the radiation intensity is one-half the maximum value of the **lobe.**

half width. See **line width.**

Hall constant. In an electrical **conductor,** the constant of proportionality R in the relation

$$E_h = RJ \times H$$

where E_h is transverse electric field (Hall field); J is current density; and H is magnetic field.

The sign of the majority carrier can be inferred from the sign of the Hall constant.

Hall effect. The electrical **polarization** of a horizontal conducting sheet of limited extent, when that sheet moves laterally through a **magnetic field** having a component vertical to the sheet.

The Hall effect is important in determining the behavior of the electrical currents generated by winds in the lower ionosphere.

Hall mobility. A measure of the flow of charged **particles** perpendicular to both a **magnetic** and an **electric field.**

hangfire. A faulty condition in the **ignition system** of a **rocket engine.**

hard landing. An impact landing of a spacecraft on the surface of a **planet** or natural **satellite** destroying all equipment except possibly a very rugged package.

hardness. Resistance of metal to plastic deformation usually by indentation. However, the term may also refer to stiffness or temper, or to resistance to scratching, abrasion, or cutting.

Indentation hardness may be measured by various hardness tests, such as Brinnell, Rockwell, and Vickers.

hard radiation. Radiation of high penetrating power; that is, **radiation** of high **frequency** and short **wavelength.**

A 10-centimeter thickness of lead is usually used as the criterion upon which the relative penetrating power of various types of radiation is based. Hard radiation will penetrate such a shield; soft radiation will not.

hard vacuum. A very **high vacuum,** usually considered to be a pressure less than about 10^{-7} torr.

hardware. Physical equipment as contrasted to ideas or design that may exist only on paper.

hard wire telemetry = wire link telemetry.

harmonic. 1. An integral multiple or submultiple of a given **frequency; a sinusoidal** component of a periodic **wave.** 2. A **signal** having a frequency which is a harmonic (sense 1) of the fundamental frequency.

harmonic analysis. A statistical method for determining the **amplitude** and **period** of certain **harmonic** or wave components in a set of data with the aid of **Fourier series.**

harmonic analyzer. A machine which resolves a **periodic** curve into its **harmonic** constituents.

A machine performing the opposite function is called a *harmonic synthesizer.*

harmonic distortion. Nonlinear **distortion** characterized by the appearance in the output of multiples of the **fundamental** when the input wave is **sinusoidal.**

harmonic function. Any solution of the **Laplace equation.**

harmonic motion. The projection of circular motion on a diameter of the circle of such motion.

Simple harmonic motion is produced if the circular motion is of constant speed. The combination of two or more simple harmonic motions results in compound harmonic motion.

harmonics of the earth's gravitational fields. A series representing the **gravitational** potentials of the earth in which the terms form a **harmonic** progression.

harmonic synthesizer. A machine which combines elementary harmonic constituents into a single periodic function.

A machine performing the opposite function is called a *harmonic analyzer.*

hartley. A unit of **information content** equal to one of ten possible and equally likely values

or states of anything used to store or convey information. One hartley equals $\log_2 10$ **bits** ($\log_2 10 = 3.323$), or one **decimal digit.**

Hartley bands. See **absorption band.**

hazemeter = **transmissometer.**

H-display. In radar, a **B-display** modified to include indication of **angle of elevation.** The **target** appears as two closely spaced **blips** which approximate a short bright line, the slope of which is in proportion to the sine of the angle of elevation. Also called *H-scan, H-scope, H-indicator.*

heading. The horizontal direction in which a craft is pointed, expressed as angular distance from a reference direction, usually from 0° at the reference direction clockwise through 360°.

Heading is often designated as *true, magnetic, compass,* or *grid* as the reference direction is true, magnetic, compass, or grid north, respectively.

heading-upward plan position indicator. See **plan position indicator.**

head pressure = **inlet pressure.**

head-to-foot acceleration. See **physiological acceleration.**

heat. Energy transferred by a **thermal** process.

Heat can be measured in terms of the dynamical units of energy, as the erg, joule, etc., or in terms of the amount of energy required to produce a definite thermal change in some substance, as, for example, the energy required per degree to raise the temperature of a unit mass of water at some temperature (**calorie, Btu**).

heat balance. 1. The equilibrium which exists on the average between the **radiation** received by **a planet** and its atmosphere from the sun and that emitted by the planet and atmosphere.

That the equilibrium does exist in the mean is demonstrated by the observed long-term constancy of the earth's surface temperature. On the average, regions of the earth nearer the equator than about 35° latitude receive more energy from the sun than they are able to radiate, whereas latitudes higher than 35° received less. The excess of heat is carried from low latitudes to higher latitudes by atmospheric and oceanic circulations and is reradiated there.

2. The equilibrium which is known to exist when all sources of heat gain and loss for a given region or body are accounted for. In general this balance includes advective, evaporative (etc.) terms as well as a radiation term.

heat barrier = **thermal barrier.**

heat conductivity = **thermal conductivity.**

heat dump = **heat sink.**

heat engine. A system which receives **energy** in the form of heat and which, in the performance of an energy transformation, does work. See **thermodynamic efficiency, Carnot engine.**

The atmosphere itself is a heat engine.

heat exchanger. A device for transferring heat from one fluid to another without intermixing the fluids, as **(a)** a **regenerator** and, **(b)** an apparatus for cooling or heating the air in a wind tunnel. See **radiator,** sense **2.**

heat function = **enthalpy.**

heat index. The difference between the absolute **visual magnitude** of a star and the absolute **radiometric magnitude** ($M_v - M_r$).

heat of ablation. A measure of the effective heat capacity of an **ablating material,** numerically the heating rate input divided by the mass loss rate which results from **ablation.**

In the most general case, heat of ablation is given by

$$(q_c + q_r - \sigma\epsilon T_w^4)/\dot{m}$$

where q_c is convective heat transfer in the absence of ablation; q_r is radiative heat transfer from hot gases to ablation material; $\sigma\epsilon T_w^4$ is rate of heat rejection by radiation from external surface of ablation material; and $\dot{m}$ is rate at which gaseous ablation products are injected into the boundary layer.

Heat of ablation is sometimes evaluated neglecting the heat rejected by radiation and as a result unrealistically high heats of ablation are obtained.

If $q_r < \sigma\epsilon T_w^4$, for moderate values of stream enthalphy h_s, heat of ablation is given by

$$H_v + \eta\,(h_s - h_w)$$

where H_v is heat required to cause a unit weight of mass to be injected into boundary layer; η is blocking factor with numerical value from about 0.2 to 0.6 depending on material and type of flow; and h_w is enthalpy at wall temperature.

heat of fusion. See **latent heat.**

heat of sublimation. See **latent heat.**

heat of vaporization. See **latent heat.**

heat pulse. Specifically, the sudden rise and subsequent fall in the temperature of a vehicle on reentry.

heat shield. 1. Any device that protects something from heat. **2.** Specifically, the protective structure necessary to protect a **reentry** body from **aerodynamic heating.** See **heat sink.**

heat sink. 1. In thermodynamic theory, a means by which **heat** is stored, or is dissipated or transferred from the **system** under consideration. **2.** A place toward which the heat moves in a system. **3.** A material capable of absorbing heat; a device utilizing such a material and used as a thermal protection device on a **spacecraft** or **reentry** vehicle. **4.** In nuclear propulsion, any thermodynamic device, such as a **radiator** or **condenser,** that is designed to absorb the excess heat energy of the **working fluid.** Also called *heat dump.*

heat transfer. The transfer or exchange of **heat** by radiation, conduction, or convection within a substance and between the substance and its surroundings.

Radiation represents the transfer of radiant energy from one region to another by electromagnetic waves, with or without an intervening medium. Conduction,

or diffusion of heat, implies the elastic impact of fluid molecules, without any net transfer of matter. Convection arises from the mixing of relatively large volumes of fluid because of the fluid motion and may be due either to local temperature inequalities (free convection) or to an applied pressure gradient (forced convection).

heat-transfer coefficient. **1.** The rate of **heat transfer** per unit area per unit temperature difference, a quantity having the dimensions of reciprocal length. **2.** A misnomer for **Nusselt number.**

heat treatment. Heating and cooling a solid metal or alloy in such a way as to obtain desired conditions or properties.

Heating for the sole purpose of hot-working is excluded from the meaning of this definition.

heavenly body = celestial body.

Heaviside layer = E-layer.

heavy cosmic-ray primaries. The positively charged **nuclei** of elements heavier than hydrogen and helium up to atomic nuclei of iron. See **cosmic rays.**

These heavy atomic nuclei comprise about 1 percent of the total cosmic-ray particles and less than 4 percent of the total positive charges.

heavy hydrogen = deuterium.

heavy ion = large ion.

heavy water. **Water** in which the hydrogen of the water molecule consists entirely of the heavy hydrogen isotope of mass 2 (**deuterium**).

Written D_2O. Density, 1.1076 at 20° C. It is used as a moderator in certain types of nuclear reactors.

The term is sometimes applied to water whose deuterium content is greater than natural water.

hecto (*abbr* **h**). A prefix meaning multiplied by 10^2.

hectometric wave. See **frequency bands.**

height (*symbol* ***h***). **1.** Vertical distance; the distance above some reference point or plane, as, height above sea level. See **altitude.** **2.** The vertical dimension of anything; the distance which something extends above its foot or root, as *blade height.*

height effect = antenna effect.

height gain. A radio-wave **interference** phenomenon which results in a more or less periodic **signal strength** variation with height. This specifically refers to interference between direct and surface-reflected waves. See **radiation pattern, Fresnel zone.**

helical antenna. An **antenna** used where **circular polarization** is required. The driven element consists of a helix supported above a ground plane.

helical scanning. In **radar scanning,** varying the **azimuth** and elevation of the antenna continuously to generate a spiral pattern of the beam. Also called **spiral scanning.**

heliocentric. Relative to the sun as a center, as a *heliocentric orbit.*

heliocentric parallax. The difference in the **apparent positions** of a **celestial body** outside the solar system, as observed from the earth and sun. Also called *stellar parallax.* See **parallax.**

heliographic. Referring to positions on the sun measured in **latitude** from the sun's equator and in **longitude** from a reference meridian.

Helmholtz free energy = Helmholtz function.

Helmholtz function (*symbol* ***a***). A mathematically defined **thermodynamic function of state,** the decrease in which during a reversible **isothermal process** is equal to the work done by the system. The Helmholtz function is

$$a = u - Ts$$

where u is specific internal energy; T is Kelvin temperature; and s is specific entropy. By use of the first law of thermodynamics for reversible processes,

$$da = -s\,dT - dw$$

where dw is the work done per unit mass by the system. Also called *Helmholtz free energy, work function.* Compare **Gibbs function.**

Helmholtz theorem. The statement that if F is a vector field satisfying certain quite general mathematical conditions, then F is the sum of two vectors, one of which is irrotational (has no **vorticity**), the other solenoidal (has no **divergence**).

hemispherical. Referring to thermal radiation properties, in all possible directions from a flat surface.

hemispherical emittance (*symbol* ϵ_h, E_h). The ratio of the emissive power of a specimen to that of a black body at the same temperature, considering radiation emitted in all possible directions.

hemmungspunkt = stopping point.

henry (*abbr* **h**). The unit of electrical inductance; the inductance of a closed circuit in which an electromotive force of 1 **volt** is produced when the electric current in the circuit varies uniformly at the rate of 1 **ampere** per second.

Her, Herc. International Astronomical Union abbreviations for *Hercules.* See **constellation.**

Hercules (*abbr* **Her, Herc**). See **constellation.**

hertz (*abbr* **Hz**). The unit of **frequency,** cycles per second.

Hertzian waves. **Electromagnetic waves** of

any **frequency** between 10 kilocycles per second and 300,000 megacycles per second. Now generally called *radio waves.* See **frequency bands.**

Herzberg bands. See **absorption band.**

heterodyne. To mix two radio **signals** of different **frequencies** to produce a third signal which is of lower frequency; i.e., to produce **beating.**

Radar receivers are of the heterodyne type (as contrasted to the superregenerative type) because the very high radio frequencies used in radar are difficult to amplify. A target signal is heterodyned with a current of lower frequency produced by a klystron oscillator and the resulting intermediate-frequency signal can then be highly amplified for subsequent presentation or analysis.

heterosphere. The upper portion of a two-part division of the **atmosphere** according to the general homogeniety of atmospheric composition; the layer above the **homosphere.** The heterosphere is characterized by variation in composition and mean molecular weight of constituent gases. See **atmospheric shell.**

This region starts at 80 to 100 kilometers above the earth, and therefore closely coincides with the ionosphere and the thermosphere.

hexidecimal notation = **sexidecimal notation.**

hibernating spacecraft. A **spacecraft** maintaining an **orbit** without using **propellant** power and without maintaining orientation within the orbit, but with inherent power capability.

A hibernating spacecraft could be in an orbit around the sun for months or years before power is triggered from a station on earth at an opportune time.

hidyne. Variant of *hydyne.*

high frequency (*abbr* **HF**). See **frequency bands.**

high-intensity gamma. A level of **gamma-radiation** flux on the order of 10^4 **roentgens** or higher.

high-pass filter. A **wave filter** having a single transmission **band** extending from some critical or cutoff frequency, not zero, up to infinite frequency.

high-precision shoran (*abbr* **hiran**). See **shoran.**

high-speed motion-picture photography. The picture-taking frequency range from 32 to 500 pictures per second.

high vacuum. The condition in a gas-filled space at pressures less than 10^{-3} **torr.**

The term *high vacuum* has frequently been defined as a pressure less than some upper limit. *High vacuum* (and similar vacuum terms) should not be defined as a pressure but rather as the condition or state in a gas-filled space at pressures less than some upper limit or within specified limits.

The following classification of degrees of *high vacuum* has been proposed:

Condition	*Pressure Range*
high vacuum	10^{-3} to 10^{-6} torr (microtorr range)
very high vacuum	10^{-6} to 10^{-9} torr (nanotorr range)
ultrahigh vacuum	10^{-9} torr and below

H-indicator = **H-display.**

hiran (*abbr*) = ***high* precision *shoran*.** See **shoran.**

hiss. Random **noise** in the **audiofrequency range,** having subjective characteristics analogous to prolonged sibilant sounds.

hohlraum. In radiation thermodynamics, a cavity whose walls are in radiative equilibrium with the **radiant energy** within the cavity.

This idealized cavity can be approximated in practice by making a small perforation in the walls of a hollow container of any opaque material. The radiation escaping through such a perforation will be a good approximation to **black-body radiation** at the temperature of the interior of the container.

Hohmann orbit. A minimum energy **transfer orbit.**

hold. 1. During a **countdown** to stop counting and to wait until an impediment has been removed so that the countdown can be resumed, as in *T minus 40 and holding.* Compare **count, recycle. 2.** In computer terminology, to retain information in one **storage** device after copying it into another storage device.

holddown = **holddown test.**

holddown test. The testing of some system or subsystem in a **rocket** while the rocket is firing but restrained in a **test stand.**

holding beam. An **electron beam** which regenerates the electrostatic charges stored in an **electrostatic-storage** tube.

hole. A mobile vacancy in the electronic valence structure of a **semiconductor** which acts like an **electron** with a positive charge.

home. To follow a path of energy **waves,** especially **radio** or **radar** waves, by means of a **directional antenna,** radar equipment, or other sensing devices, to or toward the point of transmission or reflection of the waves.

homer = **homing beacon.**

homing. The following of a path of energy **waves** to or toward their source or point of reflection. See **home, active homing, passive homing, semiactive homing guidance.**

homing beacon. A beacon providing **homing guidance.** Also called *homer.*

homing guidance. Guidance in which a craft or missile is directed toward a destination by means of information received from the destination.

It is *active* homing guidance if the information received

is in response to transmissions from the craft, *semiactive* homing guidance if in response to transmissions from a source other than the craft, and *passive* homing guidance if natural radiations from the destination are utilized.

homogeneous atmosphere. **1.** A hypothetical **atmosphere** in which the density is constant with height.

The lapse rate of temperature in such an atmosphere is known as the autoconvective lapse rate and is equal to g/R (or approximately 3.4° C per 100 meters) where g is the acceleration of gravity and R is the gas constant for air. A homogeneous atmosphere has a finite total thickness which is given by R_dT_v/g, where R_d is the gas constant for dry air and T_v is the virtual temperature (°K) at the surface. For a surface temperature of 273° K, the vertical extent of the homogeneous atmosphere on the earth is approximately 8000 meters. At the top of such an atmosphere both the pressure and absolute temperature vanish.

2. With respect to radio propagation, an atmosphere which has a constant **index of refraction,** or one in which radio waves travel in straight lines at constant speed. Free space is the ideal *homogeneous atmosphere* in this sense. **3.** Same as *adiabatic atmosphere.* See **barotrophy.**

homologous turbulence. **Turbulence** in which the mean value of the squares and products of the velocity components and their derivatives differ only in scale from point to point. See **isotropic turbulence.**

homopause. The top of the **homosphere,** or the level of transition between it and the **heterosphere.** See **atmospheric shell.**

The homopause probably lies between 80 and 90 kilometers, where molecular oxygen begins to dissociate into atomic oxygen. The homopause is somewhat lower in the daytime than at night.

homosphere. The lower portion of a two-part division of the **atmosphere** according to the general homogeniety of atmospheric composition; opposed to the **heterosphere.** The region in which there is no gross change in atmospheric composition, that is, all the atmosphere from the earth's surface to about 90 kilometers. See **atmospheric shell.**

The homosphere is about equivalent to the **neutrosphere,** and includes the troposphere, stratosphere, and mesosphere; it also includes the ozonosphere and at least part of the chemosphere.

honeycomb core. A lightweight strengthening material of a structure resembling a honeycomb mesh. See **sandwich construction.**

hop. Travel of a **radio wave** to the **ionsphere** and back to earth.

The number of hops a radio signal has experienced is usually designated by the expressions *one hop, two hop, multihop,* etc. The number of hops is called the *order of reflection.*

Hopfield bands. See **absorption band.**

Hor, Horo. International Astronomical Union abbreviations for *Horologium.* See **constellation.**

horizon. That **great circle** of the **celestial sphere** midway between the **zenith** and **nadir,** or a line resembling or approximating such a circle.

That line where earth and sky appear to meet, and the projection of this line upon the celestial sphere, is called *visible* or *apparent horizon.* A line resembling the visible horizon but above or below it is called a *false horizon.*

That circle of the celestial sphere formed by the intersection of the celestial sphere and a plane perpendicular to the zenith-nadir line is called *sensible horizon* if the plane is through any point, such as the eye of an observer, *geoidal horizon* if through any sea-level point, and *celestial* or *rational horizon* if through the center of the earth. The *geometrical horizon* was originally considered identical with the celestial horizon, but the expression is now more commonly used to refer to the intersection of the celestial sphere and an infinite number of straight lines tangent to the earth's surface, and radiating from the eye of the observer. If there were no terrestrial refraction, geometrical and visible horizons would coincide. An artificial horizon is a device for indicating the horizontal. A gyro horizon is a gyroscopic instrument for indicating the attitude of an aircraft with respect to the horizontal. A radio horizon is the line at which direct rays from a transmitting antenna become tangent to the earth's surface. A radar horizon is the radio horizon of a radar antenna.

horizon system of coordinates. A set of **celestial coordinates,** usually **altitude** and **azimuth,** based on the **celestial horizon** as the **primary great circle.** See **coordinate,** table.

horizontal parallax. The **geocentric parallax** of a body on the observer's horizon. This is equal to the angular **semidiameter** of the earth as seen from the body.

horizontal scanning. In **radar scanning,** rotating the antenna in **azimuth** around the horizon or in a sector. Also called **searchlighting.**

horizontal stratification. Uniform meteorological conditions at a given altitude, over the area under consideration.

The term *horizontally stratified atmosphere* is generally assumed to mean complete stratification at each altitude. It follows that the vertical profile, which need not be a standard profile, is consistent over the area under consideration. When the condition extends over a large area, the term *spherical stratification* is used.

horn. An **antenna** shaped like a horn. Also called *horn radiator.*

A horn is usually designed as an extension of a **waveguide** whose sides flare from the original waveguide size to a larger aperture size.

horn antenna = **horn.**

horn radiator = **horn.**

Horo. International Astronomical Union abbreviation for *Horologium.* See **constellation.**

Horologium (*abbr* **Hor, Horo**). See **constellation.**

hot cathode. A **cathode** that functions primarily by the process of **thermionic emission.** Also called *thermionic cathode.*

hot-cathode ionization gage. An **ionization gage** in which the ions are produced by collisions with electrons emitted from a hot filament (or cathode) and accelerated by an electric field. Also called *hot-filament ionization gage*, *ionization gage*, or simply *ion gage.*

The Bayard-Alpert ionization gage employs a tube with an electrode structure designed to minimize X-ray induced electron emission from the ion collector.

hot-filament ionization gage = hot-cathode ionization gage.

hot test. A propulsion system test conducted by actually firing the **propellants.** Compare **cold-flow test.**

hot-wire transducer. A **unilateral transducer** that depends for its operation on the change in resistance of a hot wire produced by the cooling or heating effects of a **sound wave.**

hour angle. Angular distance west of a **celestial meridian** or **hour circle;** the arc of the celestial equator, or the angle at the celestial pole, between the upper branch of a celestial meridian or hour circle and the hour circle of a **celestial body** or the **vernal equinox,** measured westward through 360°.

Hour angle is usually further designated as *local*, *Greenwich*, or *sidereal* as the origin of measurement is the local or Greenwich celestial meridian or the hour circle of the vernal equinox. See **meridian angle.**

hour circle. On the **celestial sphere, a great circle** through the celestial poles. An hour circle through the **zenith** is called a *celestial meridian.* Also called *circle of declination*, *circle of right ascension.*

H-scan = H-display.

H-scope = H-display.

Huggins bands. See **absorption band.**

hum. Electrical disturbance at the power-supply **frequency** or **harmonics** thereof.

human engineering. The activity or science of designing, building, or equipping mechanical devices or artificial environments to the anthropometric, physiological, or psychological requirements of the men who will use them.

human factors. The study of psychophysical, psychological, and physiological variables which affect man's performance in an operational system. See **human engineering.**

humidity. **1.** The amount of **water vapor** in the air. **2.** Specifically, **relative humidity.** See **absolute humidity, dew point.**

hunt. **1.** Of an aircraft, rocket, etc.: to weave about its flightpath, as if seeking a new direction or another angle of attack, specifically, to **yaw** back and forth. **2.** Of a control surface: to rotate up and down or back and forth without being deflected by the pilot. **3.** Of a control system: to oscillate about a selected value. **4.** Of an indicator on a display: to swing back and forth or to **oscillate,** especially rather slowly.

hunting. Fluctuation about a midpoint due to **instability,** as **oscillations** of the needle of an instrument about the zero point, or alternate lead and lag of a synchronous motor with respect to the alternating current.

Huygens principle. A very general principle applying to all forms of **wave motion** which states that every point on the instantaneous position of an advancing **phase front** (wave front) may be regarded as a source of secondary spherical wavelets. The position of the phase front a moment later is then determined as the envelope of all the secondary wavelets (ad infinitum).

This principle, stated by the Dutch physicist Christian Huygens (1629–95), is extremely useful in understanding effects due to refraction, reflection, diffraction, and scattering of all types of radiation, including sonic radiation as well as electromagnetic radiation and applying even to ocean-wave propagation.

Huygens wavelets. The assemblage of secondary waves asserted by Huygens to be set up at each instant at all points on the advancing surface of a wave, or **phase front.**

Many phenomena of wave optics can be neatly explained on this assumption (**Huygens principle**) of the continual creation of new wavelets and the subsequent destructive or constructive interference between the wavelets to set up the next-imagined state of the advancing wave front.

Hya, Hyda. International Astronomical Union abbreviations for *Hydra.* See **constellation.**

Hydi. International Astronomical Union abbreviation for *Hydrus.* See **constellation.**

Hydra (*abbr* **Hya, Hyda**). See **constellation.**

hydrodynamics. The study of fluid motion. See **aerodynamics.**

Fluid here refers ambiguously to liquids and gases.

hydromagnetics = magnetohydrodynamics.

hydrometeor. Any product of **condensation** or **sublimation** of atmospheric **water vapor,** such as rain, snow, fog, or frost. See **meteor,** sense **2.**

hydrometer. An instrument used for measuring the specific gravity of a liquid.

hydrophone. A **microphone** suitable for use in water or other liquid.

hydrosphere. That part of the earth that consists of the oceans, seas, lakes, and rivers; a similar part of any other spatial body if such a body exists.

hydrostatic equation. In numerical equations, the form assumed by the vertical component of the vector **equation of motion** when all coriolis, earth-curvature, frictional, and vertical-acceleration terms are considered negligible compared with those involving the vertical pressure force and the force of gravity. Thus,

$$dP = -\rho g dZ$$

where P is the atmospheric pressure; ρ is the density; g is the acceleration of gravity; and Z is the geometric height.

For cyclonic-scale motions the error committed in applying the hydrostatic equation to the earth's atmosphere is less than 0.01 percent. Strong vertical accelerations in thunderstorms and mountain waves may be 1 percent of gravity or more in extreme situations.

hydrostatic equilibrium. **1.** The state of a **fluid** whose surfaces of constant pressure and constant mass (or density) coincide and are horizontal throughout. Complete balance exists between the force of **gravity** and the pressure force. See **hydrostatic equation.** **2.** Of a rotating body, a state in which the body maintains, or returns to, the figure generated by this rotation in spite of small disturbances.

Hydrus (*abbr* **Hyi, Hydi**). See **constellation.**

hydyne. A hydrazine-base **liquid rocket** fuel. Also called *hidyne.*

Hyi, Hydi. International Astronomical Union abbreviations for *Hydrus.* See **constellation.**

hyperbaric. Pertaining to breathing atmosphere pressures above sea level normal.

hyperbarism. Disturbances in the body resulting from an excess of the **ambient pressure** over that within the body fluids, tissues, and cavities.

hyperbola. An open curve with two branches, all points of which have a constant difference in distance from two fixed points called *focuses.*

hyperbolic. Of or pertaining to a **hyperbola.**

hyperbolic Dovap (*abbr* **Hyperdop**). A system utilizing four or more **Dovap** stations with a common reference signal which is not **coherent** with the interrogation signal.

Hyperboloids of position are obtained by differencing phase of one station against another. Space position is computed by intersection of three or more hyperboloids of position.

hyperbolic error. The error in an **interferometer** system arising from the assumption that the directions of the **wave fronts** incident at two antennas of a **baseline** are parallel, whereby the equiphase path is a cone.

Mathematically, the equiphase path is a hyperbola.

hyperbolic fix. A fix established by means of **hyperbolic lines of position.**

hyperbolic guidance. The **guidance** of a rocket or the like in which radio signals, transmitted simultaneously from two ground stations, arrive at the guided object with a constant time difference, thereby establishing a **hyperbolic line of position** which the object follows.

hyperbolic line of position. A line of position in the shape of a **hyperbola,** determined by measuring the difference in distance to two fixed points. **Loran** lines of position are an example.

hyperbolic navigation. Radio navigation in which a **hyperbolic line of position** is established by signals received from two stations at a constant time difference.

hyperbolic system. A system where **lines of position** are determined from time or **phase** differences relative to two or more fixed stations which are the focuses of **hyperbolas.**

In a three-dimensional system, the lines of position become hyperbolic surfaces of position.

hyperbolic velocity. A velocity sufficient to allow escape from the solar system.

Comets unless captured by the sun have hyperbolic velocities and their trajectories are hyperbolas.

Hyperdop (*abbr*) = ***hyperbolic Dovap.***

hypergolic propellants. Rocket **propellants** that ignite spontaneously when mixed with each other.

Hyperion. A **satellite** of Saturn orbiting at a mean distance of 1,481,000 kilometers.

hyperon. In the classification of **subatomic particles** according to mass, the heaviest of such particles. Compare **lepton, meson, nucleon.**

Some large and highly unstable components of cosmic rays are hyperons.

hyperoxia. A condition in which the total oxygen content of the body is increased above that normally existing at sea level.

hypersonic. **1.** Pertaining to **hypersonic flow.** **2.** Pertaining to speeds of Mach 5 or greater.

hypersonic flow. In aerodynamics, **flow** of a fluid over a body at speeds much greater than the speed of sound and in which the shock waves start at a finite distance from the surface of the body. Compare **supersonic flow.**

hypersonic glider. An unpowered vehicle, specifically a **reentry vehicle,** designed to fly at **hypersonic** speeds.

hypersonics. That branch of **aerodynamics** that deals with **hypersonic flow.**

hypervelocity. Extremely high velocity.

Applied by physicists to speeds approaching the speed of light, but generally implies speeds of the order of **satellite** speed and greater.

hyperventilation. Overbreathing. A respira-

tory-minute volume, or pulmonary ventilation, that is greater than normal.

Hyperventilation often results in an abnormal loss of carbon dioxide from the lungs and blood, which may lead to dizziness, confusion, and muscular cramps.

hyperventilation syndrome. The syndrome of blurring of vision, (feeling of) tingling of the extremities, faintness, and dizziness, which may progress to unconsciousness, and convulsions, caused by reduction of the normal carbon dioxide tension of the human body, due to increased **pulmonary ventilation.**

hypobaric. Pertaining to low atmospheric pressure, particularly the low atmospheric pressure of high altitudes.

hypobarism. Disturbances resulting from a decrease of **ambient pressure** to less than that within the body fluids, tissues, and cavities.

hypocapnia. Deficiency of carbon dioxide in the blood and body tissues, which may result in dizziness, confusion, and muscular cramps.

hypothetical parallax = dynamic parallax.

hypoventilation. A respiratory-minute volume, or **pulmonary ventilation,** that is less than normal. Also called *underbreathing.*

hypoxaemia. The condition of reduction of the normal oxygen tension in the blood. Also called *anoxaemia.*

hypoxia. Oxygen want or deficiency; any state wherein a physiologically inadequate amount of oxygen is available to, or utilized by, tissue without respect to cause or degree. Compare **anoxia.**

hysteresis. 1. Any of several effects resembling a kind of internal friction, accompanied by the generation of heat within the substance affected.

Magnetic hysteresis occurs when a ferromagnetic substance is subjected to a varying magnetic intensity; electric hysteresis occurs when a dielectric is subjected to a varying electric intensity. Elastic hysteresis is the internal friction in an elastic solid subjected to varying stress.

2. The delay of an indicator in registering a change in a parameter being measured.

I

Iapetus. A **satellite** of Saturn orbiting at a mean distance of 3,562,000 kilometers.

ICAO (*abbr*) = ***I*nternational *C*ivil *A*viation *O*rganization.** Usually pronounced as a word.

ICAO Standard Atmosphere. See **standard atmosphere.**

ice frost. A thickness of ice that gathers on the outside of a **rocket** over surfaces supercooled as by liquid oxygen inside the vehicle.

This ice frost is quickly shaken loose and falls to the ground once the rocket begins its ascent.

ice point. The temperature at which a mixture of air-saturated pure water and pure ice may exist in equilibrium at a pressure of one standard atmosphere.

By decision of the Tenth General Conference on Weights and Measures, Paris, October 1954 the ice point was established as 273.15° K.

ICW (*abbr*) = ***i*nterrupted *c*ontinuous *w*ave.**

ICSU (*abbr*) = ***I*nternational *C*ouncil of *S*cientific *U*nions.** Usually pronounced as a word.

ideal exhaust velocity. The exhaust velocity of an **ideal rocket.**

ideal fluid. 1. = perfect fluid. 2. = inviscid fluid.

ideal gas. A gas which conforms to **Boyle law** and has zero heat of free expansion (or also obeys **Charles law**). Also called *perfect gas.*

ideal gas laws = gas laws.

ideal nozzle. The nozzle of an **ideal rocket,** or a nozzle designed according to the **ideal gas laws.**

ideal rocket. A theoretical **rocket** postulated for parameters that are corrected in practice.

An ideal rocket assumes a homogeneous and invariant propellant, observance of the **perfect gas laws,** no friction, no heat transfer across the rocket wall, an axially directed velocity of all exhaust gases, a uniform gas velocity across every section normal to the nozzle axis, and chemical equilibrium established in the combustion chamber and maintained in the nozzle.

ideal transducer. For connecting a specified **source** to a specified **load,** a hypothetical **passive transducer** that transfers the maximum possible power from the source to the load.

In linear electric circuits and analogous cases, this is equivalent to a transducer which (1) dissipates no energy and (2) when connected to the specified source and load presents to each its conjugate.

ideal velocity. The velocity acquired by an **ideal rocket** in field free **space,** under the influence of no external forces except the **thrust** force.

I-display. In radar, a display in which a **target** appears as a complete circle when the radar **antenna** is correctly pointed at it and in which the radius of the circle is proportional to target distance. When not correctly pointing at the target, the circle reduces to a segment of a circle, the segment length being inversely proportional to the magnitude of the **pointing error** and its angular position being reciprocal to the direction of pointing error. Also called *I-scan, I-scope, I-indicator.*

IGC-1959 (*abbr*) = ***I*nternational *G*eophysical *C*ooperation, 1959.**

igneous meteor. In U.S. weather observing practice, a visible electrical discharge in the atmosphere. Compare **electrometeor.**

Lightning is the most common and important type, but types of **corona discharge** are also included.

igniter. A device used to begin combustion, such as a spark plug in the combustion chamber of a jet engine, or a squib used to ignite the fuel in a rocket.

ignition delay. The time lapse occurring between the instance of an igniting action of a fuel and the onset of a specified burning reaction. Also called *ignition lag.*

ignition lag = ignition delay.

ignore. In computer terminology, a **code** group or **character** which indicates that the associated information is to be disregarded.

Igor (*abbr*). ***I*ntercept *g*round *o*ptical *r*ecorder.** A long-focal-length telescopic camera used to observe **attitude** and other details of a **rocket** in flight.

IGY (*abbr*) = ***I*nternational *G*eophysical *Y*ear.**

I-indicator = I-display.

illuminance. The total **luminous flux** received on a unit area of a given real or imaginary surface, expressed in such units as the **foot-candle, lux,** or **phot.** Illuminance is analogous to **irradiance,** but is to be distinguished from the latter in that *illuminance* refers only to light and contains the luminous efficiency weighting factor necessitated by the nonlinear

wavelength-response of the human eye. Compare **luminous intensity.**

The only difference between *illuminance* and *illumination* is that the latter always refers to light incident upon a material surface.

A distinction should be drawn, as well, between *illuminance* and *luminance.* The latter is a measure of the light coming from a surface; thus, for a surface which is not self-luminous, luminance is entirely dependent upon the illuminance upon that surface and its reflection properties.

illumination. See **illuminance,** note.

illuminometer = **photometer.**

ILS (*abbr*) = ***i**nstrument **l**anding **s**ystem.*

impact. 1. A single **collision** of one mass in motion with a second mass which may be either in motion or at rest. **2.** Specifically, the action or event of an object, such as a **rocket,** striking the surface of a planet or natural satellite, or striking another object; the time of this event, as in *from launch to impact.* **3.** To strike a surface or an object. **4.** Of a rocket or fallaway section: To collide with a surface or object, as in *the rocket impacted 10 minutes after launch.*

impact acceleration. The **acceleration** generated by very sudden starts or stops of a vehicle.

The term is usually applied in the context of **physiological acceleration.**

impact area. The area in which a rocket strikes the surface of the earth or other celestial body.

Used specifically in reference to the *impact area* of a rocket range.

impact line. An imaginary line on the outside of a **destruct line** and running parallel to it, which marks the outer limits of **impact** for a missile destroyed under destruct procedures.

impact microphone. An instrument that picks up the vibration of an object impinging upon another, used especially on space probes to record the impact of small **meteoroids.**

impact predictor. A device which takes information from a **trajectory measuring system** and continuously computes the point (in **real time**) at which the rocket will strike the earth; based on the assumption that the rocket power is shut off at that instant and the remaining trajectory is **ballistic** in nature.

impact pressure. 1. That **pressure** of a moving **fluid** brought to rest which is in excess of the pressure the fluid has when it does not flow, i.e., **total pressure** less **static pressure.**

Impact pressure is equal to dynamic pressure in incompressible flow, but in compressible flow impact pressure includes the pressure change owing to the compressibility effect.

2. A measured quantity obtained by placing an open-ended tube, known as an impact tube or **pitot tube,** in a gas stream and noting the pressure in the tube on a suitable **manometer.**

Since the pressure is exerted at a **stagnation point,** the impact pressure is sometimes referred to as the *stagnation pressure* or *total pressure.*

impact strength or **impact energy.** The amount of energy required to fracture a material.

The type of specimen and the testing conditions affect the values and therefore should be specified.

impact tube. See **impact pressure,** sense **2.**

impeller. 1. A device that imparts motion to a fluid; specifically, in a **centrifugal compressor,** a rotary disk which, faced on one or both sides with radial vanes, accelerates the incoming fluid outward into a **diffuser.** Also called *impeller wheel.* **2.** That part of a centrifugal compressor comprising this disk and its housing.

impeller blade = **impeller vane.**

impeller vane. Any one of the vanes on the **impeller** of a **centrifugal compressor,** serving to take in air and accelerate it radially outward. Also called *impeller blade.* Compare **compressor blade.**

impeller wheel. The vaned rotary disk in a centrifugal compressor. Usually called the *impeller.*

impingement rate. The rate per square centimeter per second at which **molecules** strike a plane surface in a **gas** at rest. Also called *rate of incidence.*

impinging-stream injector. In a **liquid-propellant rocket engine,** a device that injects the fuel and oxidizer into the **combustion chamber** in such a manner that the streams of fluid intersect one another.

implosion. The rapid inward collapsing of the walls of a vacuum system or device as the result of failure of the walls to sustain the **ambient pressure.**

impulse. 1. The product of a force and the time during which the force is applied; more specifically, the impulse is

$$\int_{t_1}^{t_2} F dt$$

where the force F is time dependent and equal to zero before time t_1 and after time t_2. **2.** (*symbol* $\mathbf{I}_t$) = **total impulse.** Compare **specific impulse.**

impulse noise. Noise generated in discrete energy bursts, not of random nature, which has a characteristic wave shape of its own.

impulse turbine. A type of **turbine** having **rotor** blades shaped so that the wheel is turned

from the impact of the fluid against the blades, with no pressure drop occurring across the blades.

inactive leg. An electrical **element** within a **transducer** which does not change its electrical characteristics as a function of the applied stimulus.

Specifically applied to elements which are employed to complete a Wheatstone bridge in certain transducers.

incandescence. Emission of light due to high temperature of the emitting material. Any other emission of light is called *luminescence.*

inch (*abbr* **in.**). Exactly 2.540 centimeters.

Prior to July 1, 1959, the inch was 2.54005 centimeters although the conversion factor 2.540 has actually been in use in industry in the United States since 1933.

incidence. 1. Partial coincidence, as a circle and a tangent line. **2.** The impingement of a **ray** on a surface. See **angle of incidence.**

incident ray. A **ray** impinging on a surface.

inclination. 1. = magnetic dip. 2. (*symbol* i). The angle between the plane of an **orbit** and a reference plane.

The **equator** is the reference plane for geocentric orbits and the **ecliptic** is the reference plane for heliocentric orbits.

included angle. In aerodynamics, the angle between **free-stream** velocity and the **longitudinal axis** of the vehicle.

incoming solar radiation. Full term for *insolation.*

incourse guidance = midcourse guidance.

increment. A change in the value of a **variable.** A negative increment is also called *decrement.*

Ind, Indi. International Astronomical Union abbreviations for *Indus.* See **constellation.**

independent variable. Any of those **variables** of a problem, chosen according to convenience, which may arbitrarily be specified, and which then determine the other or dependent variables of the problem.

The independent variables are often called the *coordinates,* particularly in problems involving motion in space. Dependent and independent variables can be interchanged, e.g., height and pressure.

index of absorption = absorptive index.

index of refraction (*symbol* n). **1.** A measure of the amount of **refraction** (a property of a **dielectric** substance). It is the ratio of the wavelength or phase velocity of an **electromagnetic wave** in a vacuum to that in the substance. Also called *refractive index, absolute index of refraction, absolute refractive index, refractivity.* See **modified index of refraction, N-unit, potential index of refraction.**

It can be a function of wavelength, temperature, and pressure. If the substance is nonabsorbing and nonmagnetic at any wavelength, then n^2 is equal to the **dielectric constant** at that wavelength.

The complex index of refraction is obtained when the attenuation of the wave per radian, called the *absorptive index* κ, is paired with the index of refraction. It is written

$$n^* = n(1 - i\kappa)$$

When the wave passes from one medium n_1 to another n_2, the angle of incidence ϕ and the angle of refraction ϕ', both measured with respect to the normal to the interface, are related by

$$\sin \phi / \sin \phi' = n_1^*/n_2^* = \text{constant}$$

which becomes, for a nonabsorbing medium, the ratios of the (noncomplex) indices of refraction. In the particular case that medium 2 is a vacuum, this ratio is the index of refraction of medium 1. This is known as Snell law, named after Willebrord Snell who discovered it about 1621.

2. A measure of the amount of **refraction** experienced by a ray as it passes through a refractive interface, i.e., a surface separating two media of different densities. It is the ratio of the absolute indices of refraction of the two media (see sense **1** above). Also called *refractive index, relative index of refraction.*

Indi. International Astronomical Union abbreviation for *Indus.* See **constellation.**

indicator. A device which makes information available but in which there is no provision for storage of such information, as a *radar indicator.*

indirect wave. Any **radio wave** which arrives by an indirect path, having undergone an abrupt change of direction by **refraction** or reflection. See **sky wave.**

indochinite. See **tektite.**

induced magnetism. Magnetism acquired by a piece of magnetic material while it is in a **magnetic field.** See **permanent magnetism.**

Indus (*abbr* **Ind, Indi**). See **constellation.**

inelastic collision. A collision between two particles in which changes occur both in the internal energy of one or both of the particles and in the sums, before and after collision, of their **kinetic energies.**

inert atmosphere. A gaseous medium that because of its lack of chemical reaction is used to enclose tests or equipment.

inert gas. Any one of six gases, helium, neon, argon, krypton, xenon, and radon, all of whose shells of planetary electrons contain stable numbers of electrons so that the atoms are almost completely chemically inactive. Also called *rare gas.*

All these gases are found in the earth's atmosphere but, with the exception of argon, are found only in very small amounts.

Fluorine compounds of the rare gases have only recently been discovered.

inertia. Resistance to **acceleration.**

inertia force = **inertial force.**

inertial axes. **Axes** that are not undergoing **acceleration** or **rotation.**

inertial coordinate system. A system in which the (vector) **momentum** of a particle is conserved in the absence of external forces. Thus, only in an inertial system can **Newton laws of motion** be appropriately applied.

When **relative coordinate systems** are used, moving with respect to the inertial system, apparent forces arise in Newton laws, such as the **coriolis force.**

inertial force. A **force** in a given coordinate system arising from the **inertia** of a parcel moving with respect to another coordinate system. The inertial force is proportional and directionally opposite to the accelerating force. Also called *inertia force.*

For example, the **coriolis acceleration** on a parcel moving with respect to a coordinate system fixed in space becomes an inertial force, the **coriolis force,** in a coordinate system rotating with the earth.

inertial guidance. **Guidance** by means of the measurement and integration of **acceleration** from within the craft.

inertial navigation. **Dead reckoning** performed automatically by a device which gives a continuous indication of position by integration of accelerations since leaving a starting point.

inertial orbit. The type of **orbit** described by all celestial bodies, in conformance with **Kepler laws** of celestial motion.

This applies to all satellites and spacecraft providing they are not under any type of propulsive power.

inertial space. A stationary frame of reference, or set of **coordinates,** for calculating **trajectories.**

inertial velocity. Velocity with respect to a fixed system of **coordinates.**

inferior conjunction. The **conjunction** of an **inferior planet** and the sun when the planet is between the earth and the sun.

inferior mirage. A spurious image of an object formed below the true position of that object by abnormal **refraction** conditions along the line of sight; one of the most common of all types of mirage and the opposite of a **superior mirage.**

The requirement for the appearance of an inferior mirage is a very large lapse rate of temperature in the layer of air containing the line of sight from observer to object. Compare **sinking, stooping.**

inferior planets. The planets with **orbits** smaller than that of the earth: Mercury and Venus.

inferior transit = **lower transit.**

infinity. **1.** A point, line, or region, beyond measurable limits.

A source of light is regarded as at infinity if it is at such a great distance that rays from it can be considered parallel. See **parallax.**

2. Any quantity larger than the largest quantity which can be stored in a register of a specific **computer.**

inflection. Reversal of direction of curvature.

A point at which reversal takes place is called *point of inflection* or *inflection point.*

inflection point. See **inflection.**

in-flight start. An engine **ignition sequence** after take-off and during flight. Compare **air start, ground start.**

This term includes starts both within and above the sensible atmosphere.

information. Any facts or data which can be used, transferred, or communicated.

information content. In a message or a signal from a source, the negative of the logarithm of the probability that this particular message or symbol will be emitted from the source.

The choice of logarithmic base determines the unit of information content. See **bit** and **hartley.**

The probability of a given message or symbol being emitted may depend on one or more preceding messages or symbols.

The quantity has been called *self-information.*

information gate. In **telemetry,** a device which, when triggered, allows information **pulses** to pass.

infrahuman. A live animal other than man used as a substitute for a human in life-science experiments.

infrared (*abbr* **IR**). **1.** = **infrared radiation.** **2.** Pertaining to **infrared radiation,** as an *infrared absorber.*

infrared radiation (*abbr* **IR**). **Electromagnetic radiation** lying in the wavelength interval from about 75 microns to an indefinite upper boundary sometimes arbitrarily set at 1000 microns (0.01 centimeter). Also called *long-wave radiation.*

At the lower limit of this interval, the infrared radiation spectrum is bounded by visible radiation, whereas on its upper limit it is bounded by microwave radiation of the type important in radar technology. See **electromagnetic spectrum.**

Whereas visible radiation is generated primarily by intra-atomic processes, infrared radiation is generated almost wholly by larger scale intramolecular processes, chiefly molecular rotations and internal vibrations of many types. Electrically symmetric molecules, such as the nitrogen and oxygen molecules which comprise most of the earth's atmosphere, are not capable of absorbing or emitting infrared radiation, but several of the triatomic gases, such as water vapor, carbon dioxide, and ozone, are infrared active and play important roles in the propagation of infrared radiation in the atmosphere.

Since a black body at terrestrial temperature radiates with maximum intensity in the infrared spectrum (near 10 microns), there exists a complex system of infrared radiation currents within the earth's atmosphere.

infrasonic frequency. A frequency below the **audiofrequency** range.

The word *infrasonic* may be used as a modifier to indicate a device or system intended to operate at an infrasonic frequency.

The term *subsonic* was once used in acoustics synonymously with *infrasonic*; such usage is now discouraged.

infrasonic sound. Sound whose **frequency** is below the lower pitch limit, below about 15 cycles per second.

inherited error. The error in initial values used in a computation; especially the error introduced from the previous steps in a step-by-step integration.

inhibitor. Anything that inhibits; specifically, a substance bonded, taped, or dip dried onto a **solid propellant** to restrict the burning surface and to give direction to the burning process. See **restricted propellant.**

inhibitor gate. In **telemetry,** a device which, when triggered, prevents information **pulses** from passing.

initial mass. The **mass** of a **rocket vehicle** at launch.

initial-value problem. A dynamical problem whose solution determines the state of a system at all times subsequent to a given time at which the state of the system is specified by given initial conditions. Also called *transient problem.* See **boundary-value problem.**

The initial-value problem is contrasted with the steady-state problem, in which the state of the system remains unchanged in time.

initial velocity. The **velocity** of anything at the beginning of a specific phase of its motion.

injection. **1.** The introduction of fuel, fuel and air, fuel and oxidizer, water, or other substance into an engine induction system or **combustion chamber.** **2.** The time following launching when nongravitational forces (thrust, lift, and drag) become negligible in their effect on the **trajectory** of a rocket or spacecraft. **3.** The process of putting a spacecraft up to **escape velocity.**

injector. A device that propels fuel or propellant into a combustion chamber under pressure other than atmospheric. See **impinging-stream injector.**

inlet. An entrance or orifice for the admission of fluid.

Frequently used in compounds, such as *inlet air, inlet air temperature, inlet casing, inlet duct, inlet guide vane, inlet port, inlet valve,* etc.

inlet pressure. In connection with performance data on pumps, when not otherwise specified, the total **static pressure** measured in a standard testing chamber by a **vacuum gage** located near the inlet port. Also called *intake pressure, fine pressure, head pressure.*

inner liner. Specifically, a tube mounted coaxially inside the outer cover or shell of a **combustion chamber.** Also called a *flame tube* or a *combustion-chamber liner.*

inner planets. The four **planets** nearest the sun: Mercury, Venus, Earth, and Mars. See **planet,** table.

inner product = scalar product.

in phase. The condition of two or more **cyclic** motions which are at the same part of their cycles at the same instant. Also called *in step.*

Two or more cyclic motions which are not at the same part of their cycles at the same instant are said to be *out of phase* or *out of step.*

input. **1.** The path through which **information** is applied to any device. **2.** The means for supplying information to a machine. See **input equipment.** **3.** Information or **energy** entering into a system. Compare **output.** **4.** The quantity to be measured, or otherwise operated upon, which is received by an instrument. Also called *input signal.*

For a thermometer, temperature is the input.

input axis. In a **gyro,** an **axis** normal to the **spin axis** about which a rotation of the base causes a maximum output as a function of this rotation.

input equipment. Specifically, the hardware through which **information** is fed into a **computer.**

input signal = input.

insertion. The process of putting an **artificial satellite** or **spacecraft** into **orbit.**

insolation. (Contracted from *in*coming *sol*ar radi*ation.*) **1.** In general, **solar radiation** received at the earth's surface. See **terrestrial radiation, extraterrestrial radiation, direct solar radiation, global radiation, effective terrestrial radiation, diffuse sky radiation, atmospheric radiation.** **2.** The rate at which **direct solar radiation** is incident upon a unit horizontal surface at any point on or above the surface of the earth. Compare **solar constant.**

instability. **1.** The condition of a body if, when displaced from a state of equilibrium, it continues, or tends to continue, to depart from the original condition. Compare **stability.** **2. Combustion instability.**

instantaneous readout. Transmission of data by a radio transmitter instantaneous with the computation of data to be transmitted. See **readout station, real time.**

instantaneous sound pressure. The total

instantaneous **pressure** at the point of observation minus the **static pressure.** Often called *excess pressure.*

in step = **in phase.**

instruction. **1.** Information which tells a **computer** where to obtain the **operands,** what operations to perform, what to do with the result, and, sometimes, where to obtain the next instruction. **2.** = **command.**

instruction code. An artificial language for describing or expressing the instructions which can be carried out by a **digital computer.**

In automatically sequenced computers, the instruction code is used when describing or expressing sequences of instructions, and each instruction word usually contains a part specifying the operation to be performed and one or more addresses which identify a particular location in storage. Sometimes, an address part of an instruction is not intended to specify a location in storage but is used for some other purpose.

If more than one address is used, the code is called a *multiple-address code.* In a typical instruction of a four-address code, the addresses specify the location of two operands, the destination of the result, and the location of the next instruction in the sequence. In a typical three-address code, the fourth address specifying the location of the next instruction is dispensed with and the instructions are taken from storage in a preassigned order.

In a typical one-address or single-address code, the address may specify either the location of an operand to be taken from storage, the destination of a previously prepared result, or the location of the next instruction. The arithmetic element usually contains at least two storage locations, one of which is an accumulator. For example, operations requiring two operands may obtain one operand from the main storage and the other from a storage location in the arithmetic element which is specified by the operation part.

instrument. To provide a **vehicle** or **component** with **instrumentation.**

instrumentation. **1.** The installation and use of electronic, gyroscopic, and other instruments for the purpose of detecting, measuring, recording, telemetering, processing, or analyzing different values or quantities as encountered in the flight of a rocket or spacecraft. **2.** The assemblage of such instruments in a rocket, spacecraft, or the like. **3.** A special field of engineering concerned with the design, composition, and arrangement of such instruments.

instrument landing system (*abbr* **ILS**). A system which provides, in the aircraft, a display of the lateral, longitudinal, and vertical references necessary for a landing.

intake pressure = **inlet pressure.**

integer. A whole number; a number that is not a fraction.

integral. **1.** Of or pertaining to an **integer.** **2.** Serving to form a whole or a part of a whole, as an *integral tank.*

integrally stiffened. Of structures, referring to thin-walled components in which increased section wall stiffeners and wall are formed as a single structural member rather than as two separate pieces.

integral tank. A fuel or oxidizer **tank** built within the normal contours of an aircraft or rocket vehicle and using the **skin** of the vehicle as a wall of the tank.

integrated trajectory system (*abbr* **ITS**). A multiple **trajectory measuring system** composed of several angle-measuring-equipment and distance-measuring-equipment sites whereby in-flight selection of station combination can be made to provide the best geometrical solution to space position at any given time of rocket flight.

integrating accelerometer. A **transducer** designed to measure, and capable of measuring, velocity by means of a time integration of **acceleration.**

integrator. **1.** In **digital computers,** a device for accomplishing a **numeric** approximation of the mathematical process of integration. **2.** A device whose output is proportional to the integral of an input signal.

intensity. **1.** In general, the degree or amount, usually expressed by the elemental time rate or spatial distribution of some condition or physical quantity, such as electric field, sound, magnetism, etc. **2.** With respect to **electromagnetic radiation,** a measure of the **radiant flux** per unit solid angle emanating from some source. Frequently, it is desirable to specify this as *radiant intensity* in order to distinguish it clearly from *luminous intensity.* Compare **emittance.**

Occasionally, *intensity* is used as synonymous to *flux density.* This usage does not coincide with accepted photometric and radiometric usage, but is of long standing in meteorology. See **sound intensity.**

intensity level. In **acoustics,** ten times the logarithm to the base 10 of the ratio of the **intensity** I of the sound measured to the reference intensity I_0. The reference intensity I_0 must be stated.

A generally used reference value, especially for air acoustics, is 10^{-16} watt per square centimeter.

intensity-modulated indicator. One of two general classes of radar **indicators,** in which **echoes** from **targets** are presented as spots or areas of light whose intensity or brilliance is normally a function of the power of the echo signal. Compare **amplitude-modulated indicator.** See **radarscope.**

intensity modulation. The change of the brilliance (or intensity) of the **trace** on the screen of a **cathode-ray tube** in accordance with the strength of the applied signal.

interaction parameter. In plasma physics, a measure of the relative importance of the **magnetic field** and the fluid motion when the **magnetic lines** are at least partially frozen into the fluid. It is related to the ratio of the magnetic energy density and the fluid kinetic energy.

If the interaction parameter is small, the fluid motion is hardly affected by the field; if it is large, the motion is largely controlled by the field; if it is the order of unity, the two strongly interact, with the net flow a compromise between them.

intercept = **altitude difference.**

interchange coefficient = **exchange coefficient.**

interdigitate. To aline two or more sets of **fins** or projections on a rocket so that each fin or projection of one set lies in a plane between the planes established by fins or projections of the other set or sets.

interface. **1.** A common boundary between two parts of a **system,** whether material or nonmaterial. **2.** Specifically, in a **rocket** vehicle or other mechanical assembly, a common boundary between two components. See **mating.** **3.** Specifically, in fluid dynamics, a surface separating two fluids across which there is a discontinuity of some fluid property such as density or velocity or of some derivative of these properties in a direction normal to the interface.

The equations of motion do not apply at the interface but are replaced by the **boundary conditions.**

interference. **1.** Extraneous signals, noises, etc. that hinder proper reception of the desired **signal** in electronic equipment. See **babble, clutter, cosmic noise, crosstalk, jitter, static.** **2.** The mutual effect of two or more meeting waves or vibrations of any kind. Sometimes called *wave interference.*

interference guard bands. The two **frequency bands** additional to and on either side of the authorized frequency band, which may be provided to minimize the possibility of **interference** between different radio channels.

interference region. That region in space in which **interference** between **wave trains** occurs.

In microwave propagation, it refers to the region bounded by the ray path and the surface of the earth which is above the radio horizon. Interference lobes and height-gain patterns are formed in this region by the addition of the direct and the surface-reflected wave. In contrast is the diffraction zone which lies below the radio horizon.

interferometer. An apparatus used to produce and measure **interference** from two or more **coherent** wave trains from the same source. See **radio interferometer.**

Interferometers are used to measure wavelengths, to measure angular width of sources, to determine the angular position of sources (as in satellite tracking), and for many other purposes.

interferometric. Pertaining to or measured by an interferometer.

interior ballistics. That branch of **ballistics** that deals with the propulsion of **projectiles,** i.e., the motion and behavior of projectiles in a gun barrel, the temperatures and pressures developed inside a gun barrel or rocket, etc. Sometimes called *internal ballistics.*

intermediate frequency (*abbr* **IF**). The beat frequency used in heterodyne receivers, usually the difference between the received radio-frequency signal and a locally generated signal.

intermediate ion. An **atmospheric ion** of size and mobility intermediate between the **small ion** and the **large ion.**

The mobility of this class of ions lies generally in the interval from 0.01 to 0.1 centimeter per second per volt per centimeter.

intermediate orbit. An orbit tangent to an actual orbit and having the same coordinates but not the same velocity at the point of tangency.

intermittent pressure breathing. Pressure breathing in which different pressures are used at different points in the respiratory cycle, usually with a high pressure during inspiration and lower pressure during expiration.

intermodulation. The **modulation** of the **components** of a complex wave by each other in a nonlinear system.

internal ballistics = **interior ballistics.**

internal efficiency. The **efficiency** with which a **reaction engine,** such as a rocket, converts the available thermal energy of its combustion gases into **kinetic energy** in the exhaust jet, expressed as a ratio.

internal energy. A mathematically defined **thermodynamic function of state,** interpretable through statistical mechanics as a measure of the molecular activity of the system. It appears in the **first law of thermodynamics** as

$$du = dq - dw$$

where du is the increment of specific internal energy, dq the increment of heat, and dw the increment of work done by the system per unit mass. The differential du is a perfect differential. Its integral therefore introduces a constant of integration, the *zero-point internal energy,* so that care must be taken when

absolute values of the internal energy are employed.

international candle. The unit of **luminous intensity** formerly used as the international standard. On January 1, 1948, it was replaced with the **candela,** which is equal to 58.9/60 or 0.98 international candle. Also called *English candle, British candle.*

International Geophysical Cooperation, 1959 (*abbr* **IGC-1959**). An extension of the **International Geophysical Year.**

International Geophysical Year (*abbr* **IGY**). By international agreement, a period during which greatly increased observation of world-wide geophysical phenomena is undertaken through the cooperative effort of participating nations. July 1957 to December 1958 was the first such *year*; however, precedent was set by the International Polar Years of 1882 and 1932.

International Gravity Formula. See **acceleration of gravity.**

international nautical mile. See **nautical mile.**

International Polar Year. The years 1882 and 1932, during which participating nations undertook increased observation of geophysical phenomena in polar (mostly arctic) regions. The observations were largely meteorological, but included others such as auroral and magnetic studies. This program was continued and expanded in both geographic and scientific scope as the **International Geophysical Year.**

international standard atmosphere = ICAO Standard Atmosphere; see **standard atmosphere.**

International Steam Table calorie (*abbr* **cal$_{IT}$**). A unit of heat equal to 4.1868 joules. See **calorie.**

International System of Units (*abbr* **SI**). The metric system of units based on the **meter, kilogram, second, ampere, Kelvin degree,** and **candela.** Also called *MSKA system.*

Other SI units are **hertz, radian, newton, joule watt, coulomb, volt, ohm, farad, weber,** and **tesla**.

International Year of the Quiet Sun (*abbr* **IQSY**). By international agreement, a period, July 1963 to December 1964, during which intensive observations of the sun and related geophysical phenomena are being made. Compare **International Geophysical Year.**

interpleural. Between the lungs and the chest wall.

interpreter. In computer terminology, a **circuit** or device which translates an instruction from **pseudocode** into an **instruction** or series of instructions which the **computer** can understand and obey.

interpreter code = pseudocode.

interrogation. Transmission of a radio **signal** or combination of signals intended to trigger a **transponder** or group of transponders.

interrogator. 1. A radar set or other electronic device that transmits an **interrogation. 2.** An **interrogator-responsor** or the transmitting component of an interrogator-responsor.

interrogator-responsor. A radio transmitter and receiver combined to **interrogate** a **transponder** and display the resulting replies. Often shortened to *interrogator* and sometimes called *challenger.*

intersection. In **Boolean algebra,** the operation in which concepts are described by stating that they have all the characteristics of the classes involved. *Intersection* is expressed as **AND.**

intersector = AND gate.

interval of convergence. See **power series.**

intervalometer. Any device that may be set so as to accomplish automatically a series of like actions, such as the taking of photographs, or the closure of electrical circuits, at constant predetermined intervals.

inverse. In cartography, same as **transverse.**

inverse-square law. A relation between physical quantities of the form: x proportional to $1/y^2$; where y is usually a distance; and x terms are of two kinds, forces and fluxes.

inversion. In meteorology, a departure from the usual decrease or increase with altitude of the value of an atmospheric property; also, the layer through which this departure occurs (the *inversion layer*), or the lowest altitude at which the departure is found (the *base of the inversion*).

This term almost always means a *temperature inversion*.

inversion temperature. 1. In the atmosphere, the temperature at the base of an inversion. **2.** Of a gas, a temperature above which the gas gains heat in expansion. See **Joule-Thompson effect,** note.

inverter. 1. A device for changing direct current to alternating current. **2.** In computers, a device or circuit which inverts the **polarity** of a **pulse.** Also called *NOT circuit.*

inviscid. Not viscous, not clinging or sticky; frictionless, as in *inviscid flow.*

inviscid fluid = perfect fluid.

Io. A **satellite** of Jupiter orbiting at a mean distance of 421,800 kilometers. Also called *Jupiter I.*

ion. 1. A charged **atom** or molecularly bound

group of atoms; sometimes also a free **electron** or other charged **subatomic particle.**

An *ion pair* consists of a positive ion and a negative ion (usually an electron) having charges of the same magnitude and formed from a neutral atom or molecule by the action of radiation.

In spectroscopy, the degree of ionization of an atom is indicated by a Roman numeral following the symbol for the element. An un-ionized atom is indicated by the Roman numeral *I*, a singly ionized atom, one which has lost one electron, is indicated by *II*, and so on. Thus Fe *IX* indicates the spectrum of an iron atom which has lost eight electrons.

2. In atmospheric electricity, any of several types of electrically charged submicroscopic particles normally found in the atmosphere. Atmospheric ions are of two principal types, **small ions** and **large ions,** although a class of **intermediate ions** has occasionally been reported.

The ionization process which forms small ions depends upon two distinct agencies, cosmic rays and radioactive emanations. Each of these consists of very energetic particles which ionize neutral air molecules by knocking out one or more planetary electrons. The resulting free electron and positively charged molecule (or atom) very quickly attach themselves to one or, at most, a small number of neutral air molecules, thereby forming new small ions. In the presence of Aitken nuclei, some of the small ions will in turn attach themselves to these nuclei, thereby creating new large ions.

The two main classes of ions differ widely in mobility. Only the highly mobile small ions contribute significantly to the electrical conductivity of the air under most conditions.

The intermediate ions and large ions are important in certain space charge effects, but are too sluggish to contribute much to conductivity. The processes of formation of ions are offset by certain processes of destruction of the ions (see **recombination**).

3. In chemistry, **atoms** or specific groupings of atoms which have gained or lost one or more electrons, as the *chloride ion* or *ammonium ion.* Such ions exist in aqueous solutions and in certain crystal structures.

ion column. The trail of ionized gases in the trajectory of a **meteoroid** entering the upper atmosphere; a part of the composite phenomenon known as a **meteor.** A type of **meteor train.** See **meteor.** Compare **gas cap.**

ion concentration = **ion density.**

ion counter. An apparatus which counts the number of unit charges of electricity which are contained in a sampled volume of the atmosphere. See **aspiration condenser, Ebert ion counter.** Compare **ionization chamber.**

The design of the ion counter depends upon the mobility of the ions under investigation. The general procedure is to pass a sample of the atmosphere through a charged cylindrical condenser. The type of ions collected will depend upon the capacity of the condenser and the polarizing potential. The change in the potential drop across the condenser is a measure of the ionic charge collected.

ion density. In atmospheric electricity, the number of **ions** per unit volume of a given sample of air; more particularly, the number of ions of a given type (positive **small ion,** negative small ion, positive **large ion,** etc.) per unit volume of air. Also called *ion concentration.*

Measurement of ion density is used in determining efficiency of ionizers in **ion engines.**

ion engine. A **reaction engine** in which **ions,** accelerated in an **electrostatic** field, are used as propellant. Also called *electrostatic engine.* See **electric propulsion.**

ion gage = **hot-cathode ionization gage.**

ionic conduction. Any electrical **conduction** where the current is sustained by the motion of **ions** (as opposed to **electrons**) within the conductor. All electrical conduction in the atmosphere is of this type.

ionic mobility = **ion mobility.**

ionization. The process by which neutral **atoms** or groups of atoms become electrically charged, either positively or negatively, by the loss or gain of **electrons;** or the state of a substance whose atoms or groups of atoms have become thus charged.

Ionization is a necessary process to produce propellant ions in **ion engines.**

ionization by collision. The removal of an orbital **electron** from an **atom** or **molecule** by an impacting particle (often, by the absorption of a **photon**). The atom or molecule is then left with an excess positive charge, i.e., it is positively ionized.

ionization chamber. An apparatus used to study the production of **small ions** in the atmosphere by **cosmic ray** and radioactive bombardment of air molecules.

The chamber is an airtight container usually cylindrical in shape and 25 to 50 liters in volume. An insulated electrode is centrally located in the chamber. In operation a potential is applied between the electrode and the chamber wall. The ions produced in the chamber are collected by the electrode system and measured by an electrometer.

ionization gage. A **vacuum gage** with a means of ionizing the gas molecules and a means of correlating the number and type of **ions** produced with the pressure of the gas. Various types of ionization gage are distinguished according to the method of producing the ionization. Some common types are: **hot-cathode ionization gage; cold-cathode ionization gage; radioactive ionization gage.**

ionization potential. The energy required to ionize an atom or molecule. The energy is usually given in terms of electron volts. See **work function,** note.

ionizer. A filament, grid, or porous body in an

ion engine or other device which strips an electron from the outer shell of a neutral atom to form a positively charged ion.

ionizer efficiency. The ratio of the number of **ions** emitted from an **ionizer** to the number of neutral atoms entering the ionizer.

ionizing efficiency. See **ion pair, ionizer efficiency.**

ionizing event. Any interaction by which one or more **ions** are produced.

ionizing radiation. Any **electromagnetic** or **particulate radiation** capable of producing ions, directly or indirectly, in its passage through matter.

ion mobility. In gaseous **electric conduction,** the average velocity with which a given **ion** drifts through a specified gas under the influence of an **electric field** of unit strength. Mobilities are commonly expressed in units of centimeters per second per volt per centimeter. Also called *ionic mobility.*

In a vacuum, a single gaseous ion subjected to any nonzero potential gradient would accelerate indefinitely; but in the midst of a gas the ion continually experiences collisions with gas molecules. These encounters tend to break up its trajectory into a series of short intervals of acceleration punctuated by deflections. The net result is that the ion's gross motion resembles drift at a uniform velocity. The mobility depends not only upon the nature of the ion and gas but also upon the density of the gas, for the latter controls the mean free path of the ion.

ionophone. A **unilateral transducer** in which the **sound** output results from the interaction between an ionic **plasma** and the surrounding sound transmitting medium.

ionosphere. The **atmospheric shell** characterized by a high **ion** density. Its base is at about 70 or 80 kilometers and it extends to an indefinite height.

The ionosphere is classically subdivided into *layers.* Each *layer*, except the D-layer, is supposedly characterized by a more or less regular maximum of electron density.

The D-layer exists only in the daytime. It is not strictly a layer at all, since it does not exhibit a peak of electron or ion density, but is rather a region of increasing electron and ion density, starting at about 70 to 80 kilometers and merging with the bottom of the E-layer.

The lowest clearly defined layer is the E-layer, occurring between 100 and 120 kilometers. The F_1-layer and F_2-layer occur in the general region between 150 and 300 kilometers, the F_2-layer being always present and having the higher electron density. The existence of a G-layer has been suggested, but is questionable. The portions of the ionosphere in which these *layers* tend to form are known as ionospheric *regions*, as in *D-region, E-region, F-region, G-region.*

Sudden increases in ionization are referred to as *sporadic*, as in *sporadic E* or *sporadic D.*

The above assumption that the ionosphere is stratified in the vertical into discrete layers is currently under serious question. Some evidence supports a belief that ion clouds are the basic elements of the ionosphere. Other investigations appear to reveal the ionosphere as a generally ionized region characterized by more or less random fluctuations of electron density.

ionospheric layer. See **ionosphere.**

ionospheric recorder. A radio device for determining the distribution of **virtual height** with **frequency,** and the **critical frequencies** of the various *layers* of the **ionosphere.**

A pulse at a certain frequency is transmitted vertically, and the time for its return is recorded on an oscilloscope; another pulse at a different frequency is then transmitted and timed. The process is thus repeated until the entire frequency range of interest, usually from 1 to 20 megacycles, has been explored.

ionospheric region. See **ionosphere.**

ionospheric storm. Disturbance of the **ionosphere,** resulting in anomalous variations in its characteristics and effects on radio communication. See **sudden ionospheric disturbance.**

ionospheric wave = sky wave.

ion pair. The pair of **ions,** one positively and the other negatively charged, formed by the **ionization** of an initially neutral gas atom when it collides with a high-energy **particle.**

It is customary to measure the ionizing efficiency of cosmic rays and radioactive materials in terms of the number of ion pairs they produce each second in 1 cubic centimeter of air. The symbol I is usually employed to designate the formation of one ion pair per cubic centimeter per second. Thus, cosmic rays are said to yield about 2I at sea level, and alpha particles from the radioactive gases contribute about 5I over land areas at the surface.

ion rocket. See **ion engine.**

IQSY (*abbr*) = ***I*nternational *Y*ear of the *Q*uiet *S*un.**

IR (*abbr*) = ***i*nfra*r*ed or *i*nfra*r*ed *r*adiation.**

iraser. (*I*nfrared *a*mplification by *s*timulated *e*mission of *r*adiation.) A device which amplifies in the **infrared** band. See **maser.**

irradiance = radiant flux density.

I-scan = I-display.

I-scope = I-display.

isentrope. A line of equal or constant **entropy.** See **Poisson equation.**

In meteorology, it may be considered an isopleth of potential temperature, i.e., the same as a dry **adiabat.**

isentropic. Of equal or constant **entropy** with respect to either space or time.

isobar. A line of equal or constant pressure, specifically, such a line in a weather map.

isobaric. Of equal or constant **pressure,** with respect to either space or time.

Because *isobar* is a common meteorological term, *isobaric* can be taken to mean *of isobars*, therefore leading to some ambiguity. This use should be avoided.

isobaric equivalent temperature. See **equivalent temperature,** sense **1.**

isochoric. Of equal or constant volume, usually applied to a **thermodynamic** process during

which the volume of the system remains unchanged. Compare **isosteric.**

isoclinic line. A line through points on the earth's surface having the same **magnetic dip.** See **aclinic line.** Compare **isogonic line.**

isogonic line. A line through points on the earth's surface having the same **magnetic variation.** See **agonic line.** Compare **isoclinic line.**

isogram = isopleth.

isolation. In **vibration** studies, a reduction in the capacity of a **system** to respond to an **excitation,** attained by the use of a resilient support.

isolator = vibration isolator.

isomer. 1. One of two or more **nuclides** having the same **mass number** A and **atomic number** Z, but existing for measurable times in different **quantum states** with different energies and radioactive properties.

The state of lowest energy is the ground state. Those of higher energies are metastable states. To indicate the metastable isomer, the letter m is added to the mass number in the symbol for the nuclide; thus Br^{80m}.

Commonly, the isomer of higher energy decays to one with lower energy by the process of **isometric transition.**

2. One of two or more **molecules** having the same atomic composition and molecular weight, but differing in geometrical configuration.

isomeric transition. A radioactive transition from one nuclear **isomer** to another of lower energy.

The deexcitation of the nuclei in the metastable state may occur by gamma emission or by internal conversion followed by emission of X-rays and Auger electrons, or both. It is a type of forbidden transition.

isopleth. On a chart or graph, a line of constant value of a given quantity with respect to either space or time. Also called *isogram.*

isopycnic. Of equal or constant density with respect to either space or time; equivalent to **isosteric.**

isostasy. A supposed equality existing in vertical sections of the earth, whereby the weight of any column from the surface of the earth to a constant depth is approximately the same as that of any other column of equal area, the equilibrium being maintained by plastic flow of material from one part of the earth to another.

isosteric. Of equal or constant specific volume with respect to either time or space; equivalent to **isopycnic.** Compare **isochoric.**

isotensoid structure. A filamentary structure in which the filaments are uniformly stressed throughout for the design loading condition.

isotherm. A line of equal or constant **temperature.**

A distinction is made, infrequently, between a line representing equal temperature in space, *choroisotherm,* and one representing constant temperature in time, *chronoisotherm.*

isothermal atmosphere. An **atmosphere** in **hydrostatic equilibrium** in which the temperature is constant with height and in which, therefore, the pressure decreases exponentially upward. In such an atmosphere the thickness between any two levels is given by

$$Z_B - Z_A = (R_d T_v/g) \ln(p_A/p_B)$$

where R_d is the gas constant for dry air; T_v is the virtual temperature (°K); g is the acceleration of gravity, and p_A and p_B are the pressures at the heights Z_A and Z_B, respectively. In the isothermal atmosphere there is no finite level at which the pressure vanishes. Also called *exponential atmosphere.* See **barotropy.**

isothermal equilibrium. The state of an **atmosphere** at rest, uninfluenced by any external agency, in which the conduction of heat from one part to another has, after a sufficient length of time, produced a uniform temperature throughout its entire mass. Also called *conductive equilibrium.* See **diffusive equilibrium, isothermal atmosphere.**

isothermal process. Any **thermodynamic change of state** of a system that takes place at constant temperature.

isotimic. Pertaining to a quality which has equal value in space at a particular time.

isotope. 1. One of several **nuclides** having the same number of protons in their nuclei, and hence belonging to the same **element,** but differing in the number of neutrons and therefore in mass number A, or in energy content (isomers). For example, $_6C_6^{12}$, $_6C_7^{13}$, and $_6C_8^{14}$ are carbon isotopes. Small quantitative differences in chemical properties exist between isotopes. **2.** A **radionuclide** or a preparation of an element with special isotopic composition (allobar) as an article of commerce, so called because of the principal use of such materials as radioactive tracers. **3.** In common usage, a synonym for **nuclide** (not recommended).

isotropic. In general, pertaining to a state in which a quantity or spatial derivatives thereof are independent of direction. Also called *isotropous.*

isotropic antenna = unipole.

isotropic radiation. Diffuse radiation which has exactly the same intensity in all directions.

This should not be called *perfectly diffuse radiation* because of the likelihood of confusion with the concept of a **perfectly diffuse radiator.**

isotropic radiator. An energy **source** that

radiates uniformly in all directions. Compare **perfectly diffuse radiator.**

isotropic turbulence. Turbulence in which the products and squares of the velocity components and their derivatives are independent of direction, or, more precisely, invariant with respect to rotation and reflection of the coordinate axes in a coordinate system moving with the mean motion of the fluid. Then all the normal stresses are equal and the tangential stresses are zero.

Atmospheric turbulence is generally nonisotropic, although isotropic turbulence is that most easily produced in wind tunnel experiments and forms the basis of much of the theoretical analysis of turbulent flow. A related but less restricted type of turbulence is known as *homologous turbulence*, in which the fluctuations differ only in scale at every point in the flow.

isotropous = isotropic.

J

jacket. **1.** A covering or casing of some kind. **2.** Specifically, a shell around the **combustion chamber** of a **liquid-fuel rocket,** through which the propellant is circulated in **regenerative cooling.** **3.** A coating of one material over another to prevent oxidation, micrometeoroid penetration, etc.

Jacobian. The determinant formed by the n^2 partial derivatives of n functions of n variables, when the derivatives of each function occupy one row of the determinant. For the case of two functions $f(x,y)$ and $g(x,y)$, the Jacobian $J(f,g)$ is

$$J(f,g) = \begin{vmatrix} \frac{\partial f}{\partial x} & \frac{\partial f}{\partial y} \\ \frac{\partial g}{\partial x} & \frac{\partial g}{\partial y} \end{vmatrix} = \frac{\partial f}{\partial x}\frac{\partial g}{\partial y} - \frac{\partial f}{\partial y}\frac{\partial g}{\partial x}$$

Sometimes written

$$J\left(\frac{f,g}{x,y}\right) \text{ or } \frac{\partial (f,g)}{\partial (x,y)}$$

jamming. Intentional **transmission** or reradiation of radio **signals** in such a way as to interfere with reception of desired signals by the intended receiver.

J-antenna. A half-wave **antenna,** end fed by a parallel-wire quarter-wave section having the configuration of a J.

JATO, Jato, or **jato.** (From *jet-assisted take-off.*) **1.** A take-off utilizing an auxiliary jet-producing unit or units, usually rockets, for additional thrust. Hence *JATO bottle, Jato unit,* etc.; a rocket or unit so used. Where rockets are the auxiliary units, *RATO* (which see) is the more specific term. **2.** A JATO bottle or unit; the complete auxiliary power system used for assisted take-off.

J-display. In radar, a modified **A-display** in which the time base is a circle. The target signal appears as a radial deflection from the time base. Also called *J-scan, J-scope, J-indicator.*

jerk. A **vector** that specifies the time rate of change of the **acceleration;** the third derivative of displacement with respect to time.

jerkmeter. An instrument for measuring the magnitude of the time rate of change of **acceleration.**

jet. **1.** A strong well-defined stream of **fluid** either issuing from an orifice or moving in a contracted duct, such as the jet of combustion gases issuing from a **reaction engine,** or the jet in the test section of a **wind tunnel.** See **free jet.** **2.** A tube, nozzle, or the like through which fluid passes, or from which it issues, in a jet, such as a jet in a carburetor. See **metering jet.** **3.** A **jet engine,** as, *an airplane with jets slung in pods.*

jetavator. A control surface that may be moved into or against a rocket's **jetstream,** used to change the direction of the jet flow for thrust vector control. Compare **jet vane.**

jet engine. **1.** Broadly, any **engine** that ejects a **jet** or stream of gas or fluid, obtaining all or most of its thrust by reaction to the ejection. See **reaction engine.** **2.** Specifically, an aircraft engine that derives all or most of its thrust by reaction to its ejection of combustion products (or heated air) in a jet and that obtains oxygen from the atmosphere for the combustion of its fuel (or outside air for heating, as in the case of the nuclear jet engine), distinguished in this sense from a **rocket engine.** A jet engine of this kind may have a **compressor,** commonly turbine-driven, to take in and compress air (turbojet), or it may be compressorless, taking in and compressing air by other means (**pulsejet, ramjet**).

jet nozzle. A **nozzle,** usually specially shaped, for producing a **jet,** such as the exhaust nozzle on a jet or rocket engine. See **rocket nozzle.**

jet propulsion. **1.** The propulsion of a **rocket** or other craft by means of a **reaction engine.** **2.** = **duct propulsion.**

Duct propulsion and rocket propulsion are the two forms of jet propulsion.

jetstream. A **jet** issuing from an orifice into a medium with much lower velocity, such as the stream of combustion products ejected from a **reaction engine.**

In the meteorological sense *jet stream* is two words, see following definition, but in the sense defined above, one word.

jet stream. A strong band of wind or winds in the upper **troposphere** or in the **stratosphere**, moving in a general direction from west to east and often reaching velocities of hundreds of miles an hour. See **jetstream**, note.

jet thrust. The **thrust** of a **fluid**, especially as distinguished from the thrust of a propeller.

The thrust of a rocket engine is calculated in the same manner as gross thrust of a jet engine. See *gross thrust.*

jet vane. A **vane**, either fixed or movable, used in a **jetstream**, especially in the jetstream of a **rocket**, for purposes of stability or control under conditions where external **aerodynamic** controls are ineffective. Also called *blast vane.* Compare **air vane.**

J-indicator = **J-display.**

jitter. 1. Instability of the signal or **trace** of a **cathode-ray tube. 2.** Small rapid variations in a **waveform** due to deliberate or accidental electrical or mechanical disturbances or to changes in the supply voltages, in the characteristic of components, etc.

Jodrell Bank. The site of a large **radio telescope**, located near Manchester, England; by extension, the radio telescope itself.

The radio telescope has a paraboloidal receiver 250 feet in diameter, 60 feet deep.

Johnson noise. See **thermal noise.**

Joint Long Range Proving Ground. The earliest predecessor organization and facility of the Atlantic Missile Range, activated at Cape Canaveral 1 October 1949 as a joint undertaking of the Air Force, Army, and Navy under the executive control of the Chief of Staff, USAF.

This facility became the sole responsibility of the Air Force on 16 May 1950, and became known as the Florida Missile Test Range.

joule (*abbr* **j**). A unit of energy or work in the **MKS system**; the work done when the point of application of 1 **newton** is displaced a distance of 1 meter in the direction of the force.

1 joule = 10^7 ergs = 1 watt second.

Joule constant. The ratio between heat and work units from experiments based on the **first law of thermodynamics:** 4.1858×10^7 ergs per 15° calorie. Also called *mechanical equivalent of heat.*

Joule cycle. (After James Prescott Joule, 1818–89, English physicist.) An ideal **cycle** for engines consisting of **isentropic** compression of the working substance, addition of heat at constant pressure, isentropic expansion to **ambient pressure**, and exhaust at constant pressure. Also called *Brayton cycle.*

Joule-Kelvin effect = **Joule-Thomson effect.**

Joule-Thomson coefficient (*symbol* μ). See **Joule-Thomson effect.**

Joule-Thomson effect. The decrease in temperature which takes place when a gas expands through a throttling device as a nozzle. Also called *Joule-Kelvin effect.*

The rate of change of temperature T with pressure p in the Joule-Thomson effect is called the *Joule-Thomson coefficient* (*symbol* μ):

$$\mu = \left.\frac{dT}{dp}\right]_h$$

where h denotes constant enthalpy.

For the Joule-Thomson effect to take place the gas must initially be below its inversion temperature; if above the inversion temperature, the gas will gain heat on expansion. The inversion temperature of hydrogen, for example, is approximately −183° C.

Jovian. (Latin Jovis, genitive of Jupiter) Of or pertaining to the planet Jupiter; associated with Jupiter; or similar to Jupiter, as in *Jovian planet.*

Jovian planet. Any one of the giant planets: Jupiter, Saturn, Uranus, or Neptune. Usually in plural *Jovian planets.*

JP (*abbr*) = **jet propellant.** Compare **RP.**

JP-4. A liquid fuel for jet and rocket engines, the chief ingredient of which is kerosene.

J-scan = **J-display.**

J-scope = **J-display.**

Julian day. The number of each day, as reckoned consecutively since the beginning of the present Julian period on January 1, 4713 B.C.

The Julian day is used primarily by astronomers to avoid confusion due to the use of different calendars at different times and places. The Julian day begins at noon, 12 hours later than the corresponding **civil day.** The day beginning at noon January 1, 1965, is Julian day 2,438,395.

Julian period. See **Julian day.**

jump. In computer programing, to cause the next **instruction** to be selected conditionally or unconditionally from a specified **storage** location.

jumper. A short length of conductor used to complete an electrical **circuit**, usually temporary, between terminals, or to bypass an existing circuit.

junction. In a **semiconductor** device, a region of transition between semiconducting regions of different electrical properties.

junction point = **node.**

June solstice = **summer solstice.**

Jupiter. See **planet**, table.

Jupiter I = **Io.**

Jupiter II = **Europa.**

Jupiter III = **Ganymede.**

Jupiter IV = **Callisto.**

K

Kármán street = Kármán vortex street.

Kármán vortex street. (After Theodore von Kármán, 1881–1963, Hungarian-born American scientist.) A double trail of **vortices** formed alternately on both sides of a cylinder or similar body moving at right angles to its axis through a **fluid,** the vortices in one row rotating in a direction opposite to that of the other row.

K-band. A **frequency band** used in **radar** extending approximately from 10.9 gigacycles per second to 36 gigacycles per second.

K-corona. That portion of the radiation from the solar **corona** consisting of the **continuous spectrum** scattered by **electrons.**

K-display. In radar, a modified **A-display** in which a **target** appears as a pair of vertical deflections or **blips** instead of a single deflection. When the radar **antenna** is correctly pointed at the target in azimuth, the blips are of equal height. When not correctly pointed, the difference in blip height is an indication of direction and magnitude of azimuth **pointing error.** Also called *K-scan, K-scope, K-indicator.*

Kelvin scale = Kelvin temperature scale.

Kelvin temperature scale (*abbr* **K**). An **absolute temperature scale** independent of the thermometric properties of the working substance. On this scale, the difference between two temperatures T_1 and T_2 is proportional to the heat converted into mechanical work by a **Carnot engine** operating between the **isotherms** and **adiabats** through T_1 and T_2. Also called *absolute temperature scale, thermodynamic temperature scale.*

For convenience the Kelvin degree is identified with the Celsius degree. The ice point in the Kelvin scale is 273.15° K. The triple point of water, the fundamental reference point, is 273.16° K. See **absolute zero, approximate absolute temperature scale, Rankine temperature scale.**

Kennelly-Heaviside layer = E-layer.

Kepler equation. In celestial mechanics

$$M = E - e \sin E$$

where M is mean anomaly; E is eccentric anomaly; and e is eccentricity of the orbital ellipse. See **anomaly,** note.

Keplerian. Pertaining to motion in conformance with **Kepler laws,** as *Keplerian trajectory, Keplerian ellipse.*

Kepler laws. The three empirical laws governing the motions of planets in their **orbits,** discovered by Johannes Kepler (1571–1630). These are: (a) the orbits of the planets are **ellipses,** with the sun at a common focus; (b) as a planet moves in its orbit, the line joining the planet and sun sweeps over equal areas in equal intervals of time (also called *law of equal areas*); (c) the squares of the periods of revolution of any two planets are proportional to the cubes of their mean distances from the sun.

Kepler planetary laws = Kepler laws.

kilo (*abbr* **k**). Prefix meaning multiplied by 10^3.

kilocalorie (*abbr* **kcal**). See **calorie.**

kilocycle (*abbr* **kc**). One thousand cycles or 1000 cycles per second.

kilogram (*abbr* **kg**). The unit of mass in the metric system; the mass of the International Prototype Kilogram, a cylinder of platinum-iridium alloy, stored at Seures, France, by the International Bureau of Weights and Measures.

kilogram calorie (*abbr* **kg-cal, Kcal, Cal**). See **calorie.**

kilomegacycle = gigacycle.

kilometer (*abbr* **km**). A unit of distance in the **metric system.**

1 kilometer = 3280.8 feet = 1093.6 yards = 1000 meters = 0.62137 statute miles = 0.53996 nautical miles

kilometric waves. See **frequency bands.**

K-indicator = K-display.

K-indices = magnetic K-indices.

kinematic eddy viscosity. See **kinematic viscosity.**

kinematics. The branch of mechanics dealing with the description of the motion of bodies or fluids without reference to the forces producing the motion.

kinematic viscosity (*symbol* ν). A **coefficient** defined as the ratio of the **dynamic viscosity** of a **fluid** to its density.

The kinematic viscosity of most gases increases with increasing temperature and decreasing pressure. For dry air at 0° C, the kinematic viscosity is about 0.13 square centimeter per second. In the theory of atmospheric turbulence the kinematic viscosity is usually replaced by the kinematic eddy viscosity to account for the increased internal friction due to turbulence.

kinetic energy (*symbol* E_k). The **energy** which a body possesses as a consequence of its

motion, defined as one-half the product of its mass m and the square of its speed v, $\frac{1}{2}mv^2$. The kinetic energy per unit volume of a fluid parcel is thus $\frac{1}{2}\rho v^2$, where ρ is the density and v the speed of the parcel. See **potential energy.**

For relativistic speeds the kinetic energy is given by

$$E_k = mc^2 - m_0c^2$$

where c is the velocity of light in a vacuum, m_0 is the rest mass, and m is the moving mass.

kinetic-energy equation = **mechanical-energy equation.**

kinetic pressure = **dynamic pressure.**

kinetic theory. The derivation of the bulk properties of **fluids** from the properties of their constituent **molecules,** their motions, and interactions.

kink instability. In **plasma physics,** a kinking or bending of a current-carrying filament in the **pinch-effect** geometry.

If a slight bend forms in the plasma column of a pinch, the magnetic forces are such as to increase the bend and the column is unstable.

Kirchhoff law. The **radiation law** which states that at a given temperature the ratio of the **emissivity** to the **absorptivity** for a given wavelength is the same for all bodies and is equal to the emissivity of an ideal **black body** at that temperature and wavelength.

Loosely put, this important law asserts that good absorbers of a given wavelength are also good emitters of that wavelength. It is essential to note that the Kirchhoff law relates absorption and emission at the same wavelength and at the same temperature. Also called *Kirchhoff radiation law.*

klystron. An **electron tube** for converting direct-current energy into radio frequency energy by alternately speeding up and slowing down the electrons. See **magnetron.**

knot. A nautical mile per hour, 1.1508 statute miles per hour.

Knudsen flow. The flow of **gases** through ducts and tubes under conditions intermediate between laminar **viscous flow** and **molecular flow.** Also called *transition flow.*

Knudsen gage. A gage which measures pressure in terms of the net rate of transfer of **momentum** by **molecules** between two surfaces maintained at different temperatures and separated by a distance smaller than the **mean free path** of the gas molecules. Also called *radiometer vacuum gage.*

Various types of Knudsen gage are distinguished by the names of the inventors and differ mainly in the shape and method of suspension of the movable element.

Knudsen number. A number used to describe the flow of a low density gas, equal to the ratio λ/l where λ is the mean free path of the gas molecule and l is a characteristic length, such as boundary layer thickness, or apparatus dimension.

The Knudsen number is used most commonly to define the extent to which the gas behaves like a collection of independent particles (free-molecule regime, Knudsen number much larger than unity), or like a viscous fluid (continuous regime, Knudsen number much smaller than unity). Intermediate regimes are termed **transition region.** and **slip-flow region.** See **rarefied gas dynamics,** note.

Knudsen rate of evaporation = **maximum evaporation rate.**

K-scan = **K-display.**

K-scope = **K-display.**

L

labyrinthine. Referring to the labyrinth of the inner ear which acts as an **acceleration sensor.**

Lacerta (*abbr* **Lac, Lacr**). See **constellation.**

lag. 1. The delay between change of conditions and the indication of the change on an instrument. **2.** Delay in human reaction. **3.** The amount one **cyclic** motion is behind another, expressed in degrees. The opposite is *lead.*

lag coefficient = time constant.

Lagrangian coordinates. 1. A system of **coordinates** by which **fluid parcels** are identified for all time by assigning them coordinates which do not vary with time. Examples of such coordinates are: (a) the values of any properties of the fluid conserved in the motion; or (b) more generally, the positions in space of the parcels at some arbitrarily selected moment. Subsequent positions in space of the parcels are then the dependent variables, functions of time and of the Lagrangian coordinates. Also called *material coordinates.* Compare **Eulerian coordinates.** See **Lagrangian equations. 2.** Same as generalized coodinates.

Lagrangian correlation. The **correlation** between the properties of a **flow** following a single parcel of fluid through its space and time variations. Compare **Eulerian correlation.** See **correlation coefficients.**

Lagrangian correlation coefficient. See **correlation coefficient.**

Lagrangian equations. Any of the fundamental equations of **hydrodynamics** expressed in **Lagrangian coordinates.**

Lagrangian point. One of the five solutions by Lagrange to the three-body problem in which three bodies will move as a stable configuration. In three of the solutions the bodies are in line; in the other two the bodies are at the vortices of equilateral triangles.

Lagrange predicted in 1772 that if the three bodies form an equilateral triangle revolving about one of the bodies, the system would be stable. This prediction was fulfilled in 1908 with the discovery of the asteroid Achilles approximately 60° ahead of Jupiter in Jupiter's orbit. Since then other asteroids have been discovered 60° ahead and 60° behind Jupiter.

lambert (*abbr* **L** or **l**). A unit of **luminance** (or brightness) equal to $1/\pi$ candle per square centimeter. Physically, the lambert is the luminance of a perfectly diffusing white surface receiving an **illuminance** of 1 **lumen** per square centimeter.

Lambert law. A law of physics which states that the **radiant intensity** (flux per unit solid angle) emitted in any direction from a unit radiating surface varies as the cosine of the angle between the normal to the surface and the direction of the radiation. The **radiance** (or luminance) of a radiating surface is, therefore, independent of direction. Also called *Lambert cosine law.* Compare **cosine law of illumination.**

Lambert law is not obeyed exactly by most real surfaces, but an ideal black body emits according to this law. This law is also satisfied (by definition) by the distribution of radiation from a perfectly diffuse radiator and by the radiation reflected by a perfectly diffuse reflector In accordance with Lambert law, an incandescent spherical black body when viewed from a distance appears to be simply a uniformly illuminated disk This law does not take into account any effects that may alter the radiation after it leaves the source.

Lambert law of absorption = Bouguer law.

laminar boundary layer. In **fluid flow,** layer next to a fixed boundary. The fluid velocity is zero at the boundary but the molecular viscous stress is large because the velocity gradient normal to the wall is large. See **turbulent boundary layer.**

The equations describing the flow in the laminar boundary layer are the **Navier-Stokes equations** containing only the inertia and molecular viscous terms.

laminar flow. In **fluid flow,** a smooth flow in which no crossflow of fluid particles occur between adjacent **stream lines;** hence, a flow conceived as made up of layers—commonly distinguished from **turbulent flow.**

Landau damping. The **damping** of a space charge **wave** by **electrons** which move at the **phase velocity** of the wave and gain energy transferred from the wave.

landing gear. The apparatus comprising those components of an aircraft or spacecraft that support and provide mobility for the craft on land, water, or other surface. The landing gear consists of wheels, floats, skis, **bogies,** and treads, or other devices, together with all associated struts, bracing, shock absorbers, etc.

Landing gear includes all supporting components, such as the tail wheel or tail skid, outrigger wheels or pontoons, etc., but the term is often conceived to apply only

to the principal components, i.e., to the main wheels, floats, etc., and the nose gear, if any. See **auxiliary landing gear.**

landing skid. A skid or runner used in the main landing gear of an **aerodynamic vehicle,** upon which the vehicle slides over the ground.

land mile = statute mile (5280 feet).

land return = ground return.

Langevin ion = large ion.

langley. A unit of energy per unit area, equal to 1 gram-calorie per square centimeter, commonly employed in **radiation** theory.

The langley is almost always used, in conjunction with some time unit, to express a **flux density;** but the time unit has been purposely separated in order that it may be chosen in a manner convenient to each particular problem. The unit is named in honor of the American scientist, Samuel P. Langley (1834–1906), who made many contributions to the knowledge of solar radiation.

Langmuir probe. A small metallic **conductor** or pair of conductors inserted within a **plasma** in order to sample the plasma current.

In some cases, the plasma density, electron temperature, and plasma potential can be inferred from a measurement with a Langmuir probe.

Langmuir rate of evaporation = maximum evaporation rate.

language. In electronic **computers: 1.** A system consisting of (a) a well-defined, usually finite, set of **characters;** (b) rules for combining characters with one another to form words or other expressions; and (c) a specific assignment of meaning to some of the words or expressions, usually for communicating information or data among a group of people, machines, etc. **2.** A system similar to the above but without any specific assignment of meanings. Such systems may be distinguished from sense **1** above, when necessary, by referring to them as *formal* or *uninterpreted* languages. See **code, machine language.**

Although it is sometimes convenient to study a language independently of any meanings, in all practical cases at least one set of meanings is eventually assigned.

lap belt. A safety belt that fastens across the lap. This is the usual kind of safety belt. Also called a *seat belt.*

Laplace equation. 1. The elliptic partial differential equation

$$\nabla^2\varphi = 0$$

where φ is a scalar function of position, and ∇^2 is the Laplacian operator. In rectangular Cartesian coordinates x, y, z, this equation may be written

$$\frac{\partial^2\varphi}{\partial x^2} + \frac{\partial^2\varphi}{\partial y^2} + \frac{\partial^2\varphi}{\partial z^2} = 0$$

The Laplace equation is satisfied, for example, by the velocity potential in an irrotational flow, by gravitational potential in free space, by electrostatic potential in the steady flow of electric currents in solid conductors, and by the steady-state temperature distribution in solids.

A solution of the Laplace equation is called a *harmonic function.* Compare **Poisson equation.**

2. An equation for the speed of sound. See **Laplacian speed of sound.**

Laplace operator = Laplacian operator.

Laplace transform. An integral transform of a function obtained by multiplying the given function $f(t)$ by e^{-pt}, where p is a new variable, and integrating with respect to t from $t = 0$ to $t = \infty$. Also called *Laplace transformation.*

Thus, the Laplace transform of $f(t)$ is

$$f(p) = \int_0^\infty e^{-pt} f(t)\, dt$$

and may be denoted by the symbol $f(p)$. The Laplace transform is especially useful in solving initial-value problems associated with inhomogeneous linear differential equations with constant coefficients and is also quite valuable in final value analysis. See **Fourier transform.**

Laplace transformation = Laplace transform.

Laplacian operator. The mathematical operator $\nabla^2 = \nabla \cdot \nabla$ (or sometimes written Δ) where ∇ is the del-operator. In rectangular Cartesian coordinates, the Laplacian operator may be expanded in the form

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

Also called *Laplace operator.* See **Laplace equation.**

Laplacian speed of sound. The **phase speed** of a **sound wave** in a compressible fluid if the expansions and compressions are assumed to be **adiabatic.** This speed a is given by the formula

$$a^2 = (c_p/c_v)\, RT$$

where c_p and c_v are the specific heats at constant pressure and volume, respectively; R is the gas content; and T is the Kelvin temperature. The value of this speed under standard conditions in dry air is 331 meters per second. Compare **Newtonian speed of sound.** See **acoustic velocity.**

lapse rate. The decrease of an atmospheric **variable** with height, the variable being temperature, unless otherwise specified.

The term applies ambiguously to the *environmental lapse rate* and the *process lapse rate*, and the meaning must often be ascertained from the context.

large calorie = kilogram calorie. See **calorie.**

large ion. An atmospheric **ion** of relatively large mass and low mobility which is produced by the attachment of a **small ion to an Aitken nucleus.**

Also called *slow ion, heavy ion, Langevin ion.*

The ion density of large ions varies widely, depending upon the degree of atmospheric pollution. Representative low-altitude values might be 10^3 per cubic centimeter in clean country air, 10^4 per cubic centimeter in an industrial area, and 10^2 per cubic centimeter over the oceans.

Larmor frequency. See **cyclotron frequency.**

Larmor orbit. The circular motion of a charged **particle** in a uniform **magnetic field.**

Whereas the motion of the particle is unimpeded along the magnetic field, motion perpendicular to the field is always accompanied by a force perpendicular to the direction of motion and the field. The electron or ion will orbit in a plane perpendicular to the magnetic field. By adding any arbitrary velocity along the magnetic field, the total path looks like a helix. The size of the Larmor orbit or helix is proportional to the particle velocity divided by the magnetic field. In a 1-gauss field, a 1-volt electron has an orbit of about 3 centimeters, and a 1-volt proton an orbit of about 1 meter.

laser. (From *l*ight *a*mplication by *s*timulated *e*mission of *r*adiation.) A device for producing light by **emission** of **energy** stored in a molecular or atomic system when stimulated by an input **signal.**

last quarter. The **phase of the moon** when it is near west quadrature, when the eastern half of it is visible to an observer on the earth.

latch. A device that fastens one thing to another, as a **rocket** to a **launcher,** but is subject to ready release so that the things may be separated.

latency. Of a computer: the time required to establish communication with a specific **storage** location, not including transfer time; equals **access time** less **word time.**

latent heat. The *unit quantity* of **heat** required for **isothermal** change in state of a unit mass of matter.

Latent heat is termed **heat of fusion, heat of sublimation, heat of vaporization,** depending on the change of state involved.

lateral. **1.** Of or pertaining to the side; directed or moving toward the side. **2.** Of or pertaining to the **lateral axis;** directed, moving, or located along, or parallel to, the lateral axis.

lateral acceleration. Acceleration substantially along the **lateral axis** of an aircraft, rocket, etc.

lateral mirage. See **mirage.**

latitude. Angular distance from a **primary great circle** or plane. See **coordinate,** table.

Terrestrial latitude is angular distance from the equator, measured northward or southward through 90° and labeled N or S to indicate the direction of measurement; astronomical latitude is angular distance between the direction of gravity and the plane of the equator; geodetic or topographical latitude is angular distance between the plane of the equator and a normal to the spheroid; geocentric latitude is the angle between a line to the center of the earth and the plane of the equator. Geodetic and sometimes astronomical latitude are also called *geographic latitude.* Geodetic latitude is used for charts. Assumed latitude is the latitude at which an observer is assumed to be located for an observation or computation. Fictitious latitude is angular distance from a fictitious equator. Grid latitude is angular distance from a grid equator. Transverse or inverse latitude is angular distance from a transverse equator. Oblique latitude is angular distance from an oblique equator. Difference of latitude is the shorter arc of any meridian between the parallels of two places, expressed in angular measure. Magnetic latitude, magnetic inclination, or magnetic dip is angular distance between the horizontal and the direction of a line of force of the earth's magnetic field at any point. Geomagnetic latitude is angular distance from geomagnetic equator. A parallel of latitude is a circle (or approximation of a circle) of the earth, parallel to the equator, and connecting points of equal latitude; or a circle of the celestial sphere, parallel to the ecliptic. Celestial latitude is angular distance north or south of the ecliptic. Galactic latitude is angular distance north or south of the galactic equator. See **variation of latitude.**

lattice. **1.** In nuclear physics, a geometric pattern, as, the pattern in which **fuel** and **moderator** are interspersed in a heterogeneous **reactor.** **2.** Short for *crystal lattice.*

launch. **1.** The action taken in launching a **rocket** from the surface. **2.** The resultant of this action, i.e., the transition from static repose to dynamic flight by the rocket. **3.** The time at which this takes place. **4.** The action of sending forth a rocket, probe, or other object from a moving vehicle, such as an aircraft or spacecraft. See **lift-off.**

launch. **1.** To send off a rocket vehicle under its own rocket power, as in the case of guided aircraft rockets, artillery rockets, and space vehicles. **2.** To send off a missile or aircraft by means of a catapult, as in the case of the V–1, or by means of inertial force, as in the release of a bomb from a flying aircraft. **3.** To give a space probe an added boost for flight into space just before separation from its launch vehicle.

This term has different connotations than those of *fire* and *shoot.* See **lift-off.**

launch azimuth. The initial heading of a powered vehicle at **launch,** commonly applied to **launch vehicles.**

launch complex. The site, facilities, and equipment used to **launch a rocket vehicle.** See **launch site.**

The complex differs according to the type rocket or particular rocket, or according to whether land launched or ship launched. The term is sometimes considered to include the launch crew.

launch crew. A group of technicians that prepares and launches a **rocket.**

launch emplacement. A launch pad with associated equipment.

launcher. **1.** Specifically, a structure or device, often incorporating a tube, a group of tubes, or a set of tracks, from which self-propelled missiles are sent forth and by means of which

the missiles usually are aimed or imparted initial guidance—distinguished in this specific sense from a catapult. **2.** Broadly, a structure, machine, or device, including the catapult, by means of which airplanes, rockets, or the like are directed, hurled, or sent forth.

launching angle. The angle between a horizontal plane and the **longitudinal axis** of a rocket, etc., being launched.

launching base. An area such as Cape Kennedy or Vandenberg Air Force Base that has several **launch sites.**

launching pad. A **launch pad.**

launching rack. A skeletonlike structure, usually incorporating rails, from which something is launched.

launching rail. A rail that gives initial support and guidance to a **rocket** launched in a nonvertical position.

launching site = launch site.

launch pad. The load-bearing base or platform from which a **rocket vehicle** is launched. Usually called *pad.*

launch point. The **geographic position** from which a **rocket vehicle** is launched.

launch site. 1. A defined area from which a **rocket vehicle** is launched, either operationally or for test purposes; specifically, at Cape Kennedy or Vandenberg, any of the several areas equipped to **launch** a rocket. **2.** More broadly, a **launching base.** Also called *launching site.*

launch stand. A facility or station at which a **rocket vehicle** is launched, normally incorporating a **launch pad** with **launcher.** Compare **test stand.**

launch vehicle. A **rocket** or other vehicle used to launch a **probe, satellite,** or the like.

launch window. The postulated opening in the continuum of time or of space, through which a **spacecraft** or missile must be launched in order to achieve a desired encounter, rendezvous, impact, or the like. See **window.**

Laval nozzle = de Laval nozzle.

law of conservation of momentum. See **Newton laws of motion.**

law of equal areas = Kepler second law.

laws of motion. See **Newton laws of motion.**

layer. Of the ionosphere, an apparently stratified distribution of **free electrons.** See **ionosphere,** note.

L-band. A frequency band used in **radar** extending approximately from 0.390 gigacycles per second to 1.55 gigacycles per second. See **frequency band.**

L-corona. That portion of the **radiation** from the solar **corona** consisting of coronal **line emission.**

L-display. In radar, a **display** in which a **target** appears as two horizontal **blips,** one extending to the right and one to the left, from a central vertical time base. When the **radar antenna** is alined in azimuth at the target both blips are of equal amplitude. When not correctly pointed the relative blip amplitude indicates the **pointing error.** The position of the signal along the baseline indicates target distance. The display may be rotated 90° when used for elevation instead of azimuth aiming. Also called *L-scan, L-scope, L-indicator.*

L/D ratio = lift-drag ratio.

lead. The amount one **cyclic** motion is ahead of another, expressed in degrees. The opposite is lag.

leakage. In nuclear physics, loss of **neutrons** by outward diffusion from a **reactor core;** especially net loss from unreflected neutrons or escaped neutrons or by radiation through an imperfect shield.

leans. An illusion of a craft being tilted, with corresponding leaning of the crew in the opposite direction, caused by a false labyrinthine reaction uncorrected by visual cues.

leapfrogging. The process of phasing, or delaying the **ranging pulse** of a **tracking radar** in order to move, or shift (on the radarscope presentation) the target **blip** past the target blip from another radar.

leapfrog test. In computer operation, a check **routine** which eventually occupies every possible position in the **memory.**

leap year. See **calendar year.**

least squares. Any statistical procedure that involves minimizing the sum of squared **differences.**

left-handed polarized wave. An ellipitically polarized transverse **electromagnetic wave** in which the rotation of the **electric field** vector is counterclockwise for an observer looking in the direction of **propagation.** Also called *counterclockwise polarized wave.*

Lenard effect. The separation of electric charges accompanying the **aerodynamic** breakup of water drops, first studied systematically by the German physicist P. Lenard. Also called *spray electrification, waterfall effect.* Compare **Macky effect.**

Experiments have shown that the degree of charge separation in spray processes depends upon the drop temperature, presence of dissolved impurities, speed of the impinging airblast, and contact with foreign surfaces. The largest fragments of the broken drops are observed

to carry positive charges and the fine spray of drops carried off in the impinging air current carries a net negative charge.

length (*symbol* ***l***, ***ℓ***). Specifically, the dimension of an aircraft, rocket, etc., from nose to tail; the measure of this dimension. Compare **span.**

length-beam ratio = **fineness ratio.**

Leo (*abbr* **Leo, Leon**). See **constellation.**

Leo Minor (*abbr* **LMi, L Min**). See **constellation.**

Leon. International Astronomical Union abbreviation for *Leo.* See **constellation.**

Lep, Leps. International Astronomical Union abbreviations for *Lepus.* See **constellation.**

lepton. In the classification of **subatomic particles** according to mass, the lightest of all particles; examples of leptons are the **electron** and **positron.** Compare **meson, nucleon, hyperon.**

Lepus (*abbr* **Lep, Leps**). See **constellation.**

level. In **acoustics,** the logarithm of the ratio of that quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level must be specified.

Examples of kinds of levels in common use are electric-power level, sound-pressure-squared level, voltage-squared level.

Level as here defined is measured in units of the logarithm of a reference ratio that is equal to the base of logarithms.

In symbols,

$$L = \log_r (q/q_0)$$

where L is level of kind determined by the kind of quantity under consideration, measured in units of $\log_r r$; r is the base of logarithms and the reference ratio; q is the quantity under consideration; and q_0 is the reference quantity of the same kind.

Differences in the levels of two like quantities q_1 and q_2 are described by the same formula because, by the rules of logarithms, the reference quantity is automatically divided out:

$$\log_r (q_1/q_0) - \log_r (q_2/q_0) = \log_r (q_1/q_2)$$

level above threshold. In acoustics, the pressure **level** of the **sound** in decibels above its **threshold of audibility** for the individual observer or for a specified group of individuals. Also called *sensation level.*

level of escape. See **critical level of escape.**

level surface = **geopotential surface.**

Lib, Libr. International Astronomical Union abbreviations for *Libra.* See **constellation.**

Libra (*abbr* **Lib, Libr**). See **constellation.**

library. In computer operations, a collection of **programs, routines,** and **subroutines** by which problems (and parts of problems) of many types can be solved.

libration. A real or apparent oscillatory motion, particularly the apparent **oscillation** of the moon.

Because of libration more than half of the moon's surface is revealed to an observer on the earth even though the same side of the moon is always toward the earth, because the moon's periods of rotation and revolution are the same. Other motions regarded as librations are long period orbital motions and periodic perturbations in orbital elements.

life sciences. The field of scientific disciplines encompassing biology, physiology, psychology, medicine, sociology, and other related areas.

lift (*symbol* ***L***). **1.** That component of the total aerodynamic force acting on a body perpendicular to the undisturbed airflow relative to the body. **2.** To lift off, to take off in a vertical ascent. Said of a rocket vehicle. See **lift-off.**

lift coefficient (*symbol* C_L). A **coefficient** representing the **lift** of a given airfoil or other body.

The lift coefficient is obtained by dividing the lift by the free-stream dynamic pressure and by the representative area under consideration.

lift-drag ratio. The ratio of **lift** to **drag** obtained by dividing the lift by the drag or the **lift coefficient** by the **drag coefficient.** Also called *L/D ratio.*

lift-off. The action of a **rocket vehicle** as it separates from its **launch pad** in a vertical ascent. Compare **take-off.**

Lift-off is applicable only to vertical ascent; *take-off* is applicable to ascent at any angle. A *lift-off* is action performed by a rocket; a *launch* is action performed upon a rocket or upon a satellite or spaceship carried by a rocket.

light. Visible radiation (about 0.4 to 0.7 micron in wavelength) considered in terms of its **luminous efficiency,** i.e., evaluated in proportion to its ability to stimulate the sense of sight.

light discharge. See **electric discharge.**

light energy = **luminous energy.**

light intensity = **luminous intensity.**

light ion = **small ion.**

light microsecond. The distance a light **wave** travels in free space in one-millionth of a second. See **electrical distance.**

lightning discharge. See **spark discharge,** note.

lightning recorder = **sferics receiver.**

light time. The elapsed time taken by **electromagnetic radiation** to travel from a **celestial body** to the observer at the time of observation.

The American Ephemeris and Nautical Almanac uses a light time of 498.8 seconds for 1 astronomical unit.

light-year. A unit of length used in expressing stellar distances equal to the distance **electromagnetic radiation** travels in 1 year. 1 light-year = 9.460×10^{12} kilometers = 63,280 astronomical units = 0.3068 parsecs.

limb. The edge of the apparent disk of a **celestial body,** as of the sun.

limb darkening. A condition, sometimes observed on celestial objects, in which the brightness of the object decreases as the edges or **limbs** of the object are approached. The Sun and Jupiter exhibit limb darkening.

limb of the earth. The edge of the earth at the **horizon.**

limen. Threshold; a psychophysical concept denoting the lowest detectable intensity of any sensory **stimulus.**

liminal contrast = threshold contrast.

limiter. A device whose **output** is constant for all **inputs** above a predetermined value.

L-indicator = L-display.

line absorption. See **absorption spectrum.**

linear. **1.** Of or pertaining to a line. **2.** Having a relation such that a change in one quantity is accompanied by an exactly proportional change in a related quantity, such as input and output of electronic equipment.

linear acceleration (*symbol* a). The rate of change of linear velocity. See **acceleration.**

linear accelerator. A device for accelerating charged **particles** employing alternate **electrodes** and gaps arranged in a straight line, so proportioned that when their potentials are varied in the proper amplitudes and frequency, particles passing through them receive successive increments of energy.

linear array. An **antenna array** whose elements are equally spaced along a straight line.

linearly polarized sound wave = plane polarized sound wave.

linear polarization. The **polarization** of an electromagnetic wave radiated by an electric **vector** that does not rotate but that alternates so as to describe a line. Normally, the vector is oriented either horizontally or vertically. See **elliptical polarization.**

linear speed. Rate of motion in a straight line. See **angular speed.**

linear transducer. A **transducer** for which the pertinent measures of all the **waves** concerned are linearly related.

By *linearly related* is meant any relation of linear character whether by linear algebraic equation or by linear differential equation or by other linear connection.

The term *waves concerned* connotes actuating waves and related output waves, the relation of which is of primary interest in the problem at hand.

line of apsides. The line connecting the two points of an **orbit** that are nearest and farthest from the center of attraction, as the **perigee** and **apogee** of the moon or the **perihelion** and **aphelion** of a planet; the major axis of any **elliptical** orbit and extending indefinitely in both directions.

line of flight. The line in air or space along which an aircraft, spacecraft, etc., flies or travels.

line of force. A line indicating the direction in which a force acts, as in a magnetic field. See **electric lines of force, magnetic lines of force.**

line of nodes. The straight line connecting the two points of intersection of the **orbit** of a planet, planetoid, or comet and the **ecliptic,** or the line of intersection of the planes of the orbits of a **satellite** and its **primary.**

line of position. In navigation, a line representing all possible locations of a craft at a given instant.

In space this concept can be extended to *sphere of position*, *plane of position*, etc.

line of sight. **1.** The straight line between the eye of an observer and the observed object or point. Also called *optical path.* **2.** Any straight line between one point and another, or extending out from a particular point. **3.** In radio, a direct **propagation** path that does not go below the radio horizon.

line printer. A printer, often used in conjunction with a **computer,** which is capable of printing an entire line of characters at one time.

liner. In solid rockets, a layer of **inhibiter** applied to the inner surface of the chamber holding the **grain.**

line-reversal pyrometer. A **thermometer** for high-temperature gases in which the temperature of a calibrated radiator is adjusted until the spectral areal radiant **intensity** of its **continuum radiation** is equal to the intensity of radiation from some suitable characteristic **spectral line** emitted by the gas.

The comparison is made at the wavelength of the spectral line. Seeding is often used to create such a line.

line spectra. The spontaneous emission of **electromagnetic radiation** from the bound **electrons** as they jump from high to low energy levels in an atom.

This radiation is essentially at a single frequency determined by the jump in energy. Each different jump in energy level, therefore, has its own frequency and the net radiation is referred to as the line spectra. Since these line spectra are characteristic of the atom, they can be used for identification purposes.

line spectrum. A **spectrum** which contains a finite number of components within a specified **frequency** range.

line width. The finite width, expressed either

in **wavelength** units or **frequency** units, of a **spectral line** (e.g., an absorption line).

It is customary to employ, as a convenient measure of this quantity, the half-width, which is the width of the spectral line measured between the two points at which its intensity is just half the peak intensity of the line center. The bell-shaped profile of a spectral line is produced, in general, by the joint action of several factors. Each line is characterized, first of all, by a natural width which is related through quantum principles to the lifetime of the excited state of the emitting atom or molecule, in the case of lines in an emission spectrum. This natural width may be extended by Doppler broadening due to random thermal motions of the emitting or absorbing gas, by pressure broadening due to collisions between the particles involved in the radiation, and by electric fields, as in the Stark effect. Compare **equivalent width.**

Linke scale. A type of **cyanometer;** an instrument used to measure the blueness of the sky. The **Linke** scale is simply a set of eight cards of different standardized shades of blue. They are numbered 2 to 16, the odd numbers to be used by the observer if he judges the sky color to lie between any of the given shades. Also called *blue-sky scale.*

Sky-blueness study, or cyanometry, is a means of studying atmospheric turbidity.

Linke turbidity factor. See **turbidity factor,** note.

liquid. A substance in a state in which the individual particles move freely with relation to each other and take the shape of the container, but do not expand to fill the container. Compare **fluid.**

liquid fuel. A **rocket fuel** which is **liquid** under the conditions in which it is utilized in the rocket. See **liquid propellant.**

liquid level manometer. A **displacement manometer** employing a liquid as the movable partition and providing means for observing the change in level of one or both of the free surfaces.

liquid-metal corrosion. Corrosion of a vehicle's structural metal by an adjacent liquid metal used as a **coolant.**

Metals such as sodium, potassium, mercury, rubidium, etc., are used as liquid coolants.

liquid propellant (*abbr* **LP**). Specifically, a **rocket propellant** in liquid form.

Examples of liquid propellants include fuels such as *alcohol, gasoline, aniline, liquid ammonia,* and *liquid hydrogen;* oxidants such as liquid oxygen, hydrogen peroxide (also applicable as a monopropellant), and nitric acid; additives such as water; and monopropellants such as nitromethane.

liquid-propellant engine. See **liquid-propellant rocket engine.**

liquid-propellant rocket. 1. A **rocket** powered by a **liquid-propellant rocket engine. 2.** = **liquid-propellant rocket engine.**

liquid-propellant rocket engine. A rocket engine using a **propellant** or propellants in **liquid** form. Also called *liquid-propellant rocket.*

Rocket engines of this kind vary somewhat in complexity, but they consist essentially of one or more combustion chambers together with the necessary pipes, valves, pumps, injectors, etc. See **liquid propellant, rocket engine.**

liquid rocket = **liquid-propellant rocket.**

lithometeor. Solid matter suspended in the atmosphere, as smoke, dust, dry haze, etc., as contrasted with **hydrometeor.**

lithosphere. The solid part of the earth or other spatial body. Distinguished from the **atmosphere** and the **hydrosphere.** See **geosphere, biosphere.**

live testing. The testing of a **rocket** engine, vehicle, or missile by actually launching it. Compare **static testing.**

LMi, L Min. International Astronomical Union abbreviations for *Leo Minor.* See **constellation.**

load. 1. The device which receives **signal** power from a **source. 2.** The signal power delivered by a source.

The use of **load** in sense **2** is discouraged.

load factor. A number which yields the inertial load when multiplied by the weight of an object.

The load factor for a rocket is obtained by dividing the sum of the external forces by the weight of the rocket. For example, the longitudinal load factor n, is:

$$n = (F - D)/W$$

where F is rocket thrust; D is aerodynamic drag; and W is weight of missile.

The force of gravity does not appear in the sum of external forces because, on each particle of mass, the gravity force is canceled by the inertial force of free-fall acceleration.

load isolator. A **waveguide** or coaxial device which provides a good energy path from a signal **source** to a load but provides a poor energy path for reflections from a mismatched load back to the signal source.

lobe. An element of a **beam** of focused radio energy. Lobes define surfaces of equal **power density** at varying distances and directions from the radiating **antenna.**

Their configuration is governed by two factors: (**a**) the geometrical properties of the antenna reflector and feed system; and (**b**) the mutual interference between the direct and reflected rays for an antenna situated above a reflecting surface. In addition to the major lobes of an antenna system, there exist side lobes (or minor lobes) that result from the unavoidable finite size of the reflector. They exist at appreciable angles from the axis of the beam, and, while objectionable, they normally contain much less energy than that in the major lobe. See **radiation pattern.**

lobe pattern = **radiation pattern.** See **lobe.**

local. In astronomy, referred to a reference

line passing through a particular place other than **Greenwich,** as **local meridian.**

local angular momentum. In meteorology, **angular momentum** about an arbitrarily located vertical **axis** which is fixed in reference to the earth.

local apparent time. The arc of the **celestial equator,** or the angle at the celestial pole, between the lower branch of the local **celestial meridian** and the **hour circle** of the apparent or **true sun,** measured westward from the lower branch of the local celestial meridian through 24 hours; **local hour angle** of the apparent or true sun, expressed in time units, plus 12 hours.

local astronomical time. Mean time reckoned from the **upper branch** of the **local meridian.**

local civil time (*abbr* **LCT**). See **local mean time**, note.

local lunar time. The arc of the **celestial equator,** or the angle at the celestial pole, between the lower branch of the local **celestial meridian** and the **hour circle** of the moon, measured westward from the lower branch of the local celestial meridian through 24 hours; local hour angle of the moon, expressed in time units, plus 12 hours. See **lunar time.**

local mean time (*abbr* **LMT**). The arc of the **celestial equator,** or the angle at the celestial pole, between the lower branch of the local **celestial meridian** and the **hour circle** of the **mean sun,** measured westward from the lower branch of the local celestial meridian through 24 hours; local **hour angle** of the mean sun, expressed in time units, plus 12 hours. Mean time reckoned from the upper branch of the local meridian is called *local astronomical time.*

Local mean time at the Greenwich meridian is called *Greenwich mean time*, or *universal time*. It was called *local civil time* in United States terminology from 1925 through 1952.

local meridian. The meridian through any particular place or observer, serving as the reference for **local time,** in contrast with **Greenwich meridian.**

local sidereal time (*abbr* **LST**). **Local hour angle** of the **vernal equinox,** expressed in time units; the arc of the **celestial equator,** or the angle at the celestial pole, between the upper branch of the local **celestial meridian** and the hour circle of the vernal equinox, measured westward from the upper branch of the local celestial meridian through 24 hours.

local time. Time based upon the **local meridian** as reference, as contrasted with that based upon a zone meridian, or the meridian of **Greenwich.**

local velocity. The velocity of a particular point on an object relative to its surrounding **fluid.** See **remote velocity.**

lock, to lock on. **1.** Of a **radar** or other sensing and **tracking** device. To acquire a particular object of interest and continue tracking it automatically. **2.** In **phase-lock** radio receivers, to adjust the frequency of the voltage controlled oscillation, to the point where it is controlled by signal power from the detector. **3.** In coded **ranging systems,** to adjust the ground generated code until it exactly matches in time and code the transmitted code.

lockup. A pneumatic regulator which shuts off flow to a volume (tank) at the set regulation point or *lockup pressure.*

logarithm. The **power** to which a fixed number, called *the base*, usually 10 or *e* (2.7182818), must be raised to produce the value to which the logarithm corresponds.

An antilogarithm or inverse logarithm is the value corresponding to a given logarithm. A cologarithm is the logarithm of the reciprocal of a number.

logarithmic. Pertaining to **logarithms;** in a proportion corresponding to the logarithms of numbers, as a *logarithmic scale.*

logarithmic decrement. The **natural logarithm** of the ratio of any two successive amplitudes of like sign in the **decay** of a single-frequency **oscillation.**

logarithmic scale. A scale graduated in the **logarithms** of uniformly spaced consecutive numbers.

logic. See **logical design,** sense **3.**

logical design. **1.** The planning of a **computer** or **data-processing** system prior to its detailed engineering design. **2.** The synthesizing of a network of **logical elements** to perform a specified function. **3.** The result of **1** and **2** above, frequently called the *logic* of the system, machine, or network.

logical element. In a **computer** or **data-processing** system, the smallest building blocks which can be represented by operators in an appropriate system of symbolic logic. Typical logical elements are the **AND gate** and the **flip-flop**, which can be represented as operators in a suitable symbolic logic.

logical operation. In **computer** operations, **(a)** any nonarithmetical operation (e.g., extract, bitwise multiplication, jump, data transfer, etc.) **(b)** sometimes, only those nonarithmetical operations which are expressible bitwise in

terms of the propositional calculus or a two-valued **Boolean algebra.**

long-baseline system. A **trajectory-measuring system** with receiving stations separated by distance in the order of magnitude of the distance to the target being tracked.

longitude. **1.** Angular distance, along a **primary great circle,** from the adopted reference point; the angle between a reference plane through the polar axis and a second plane through that axis. See **coordinate,** table.

Terrestrial longitude is the arc of a parallel, or the angle at the pole, between the prime meridian and the meridian of a point on the earth, measured eastward or westward from the prime meridian through 180°, and labeled E or W to indicate the direction of measurement. Astronomical longitude is the angle between the plane of the reference meridian and the plane of the celestial meridian; geodetic longitude is the angle between the plane of the reference meridian and the plane through the polar axis and the normal to the spheroid. Geodetic and sometimes astronomical longitude are also called *geographic longitude.* Geodetic longitude is used for charts. Assumed longitude is the longitude at which an observer is assumed to be located for an observation or computation. *Difference* of longitude is the smaller angle at the pole or the shorter arc of a parallel between the meridians of two places, expressed in angular measure. Fictitious longitude is the arc of the fictitious equator between the prime fictitious meridian and any given fictitious meridian. Grid longitude is angular distance between a prime grid meridian and any given grid meridian. Oblique longitude is angular distance between a prime oblique meridian and any given oblique meridian. Transverse or inverse longitude is angular distance between a prime transverse meridian and any given transverse meridian. Celestial longitude is angular distance east of the vernal equinox, along the ecliptic. Galactic longitude is angular distance east of sidereal hour angle 80°, along the galactic equator.

2. Of a planet in solar system, the sum of two angles: the **celestial longitude** of the **ascending node** of the planetary orbit, and the angle measured eastward from the ascending node along the **orbit** to the position of the planet.

longitudinal axis. The fore-and-aft line through the **center of gravity** of a craft.

longitudinal wave. A **wave** in which the direction of displacement at each point of the medium is normal to the **wave front.** Compare **transverse wave.**

long-range accuracy (*abbr* **Lorac**). A two-dimensional radio navigation system using continuous-wave transmission to provide **hyperbolic lines of position** through radiofrequency phase comparison techniques from four transmitters.

The system is used for surveying or ship-positioning. Frequency band, 1.7 to 2.5 megacycles. Similar to Raydist system in principle.

long-range navigation (*abbr* **loran**). A two-dimensional pulse-synchronized radio navigation system to determine **hyperbolic lines of position** through pulse-time differencing from a **master** compared to two **slave** stations.

Loran uses the frequency band 1.7 to 2.0 megacycles; loran C (Cytac) uses transmission at 100 kilocycles and phase compares the continuous wave in the pulse envelopes for greater accuracy using pulse technique for resolving ambiguities.

long-wave radiation. In meteorology, = **infrared radiation.**

long-wire antenna. A linear **antenna** which, by virtue of its considerable length in comparison with the operating **wavelength,** provides a directional **radiation pattern.**

look angles. The **elevation** and **azimuth** at which a particular **satellite** is predicted to be found at a specified time.

Look angles are used in satellite tracking and data acquisition to minimize the amount of searching needed to acquire the satellite in the telescope field of view or the antenna beam.

looming. A **mirage** effect produced by greater-than-normal **refraction** in the lower atmosphere, thus permitting objects to be seen that are usually below the horizon. This occurs when the air density decreases more rapidly with height than in the normal atmosphere.

If the rate of decrease of density with height is greater in the region followed by the ray from the top of the object than for the ray from the bottom of the object, the image will be stretched vertically. This stretching is often called *looming* but is more properly termed *towering.* The antonym of *looming* is *sinking* and that of *towering* is *stooping.*

loop. **1.** = **antinode.** **2.** = **mesh.** **3.** = **loop antenna.** **4.** = **feedback control loop.**

loop antenna. An **antenna** consisting of a conducting coil, of any convenient cross section (generally circular), which emits or receives radio energy. The principal **lobe** of the **radiation pattern** is wide and is in the direction perpendicular to the plane of the coil. Also called *loop.*

loop range. The total distance from a **transmitter** to a **target** to a **receiver.**

Lorac (*abbr*) = ***long-range accuracy.***

loran (*abbr*) = ***long-range navigation.***

loran C. See **long-range navigation,** note.

Lorentz force. The force affecting a charged **particle** due to the motion of the particle in a **magnetic field.** The Lorentz force is

$$F_L = q(v \times B)$$

where q is the charge on the moving object; v is the velocity of the object; and B is the magnetic induction vector.

Lorin tube = **ramjet engine.**

Loschmidt number. The number of **molecules** of an **ideal gas** per unit volume.

Loschmidt number = 2.6870×10^{19} molecules per cubic centimeter. See **Avogadro number.**

loss. A decrease in **signal power** in transmission from one point to another. Loss is usually expressed in **decibels.** Also called *transmission loss.*

loudness. The intensive attribute of an auditory sensation, in terms of which **sounds** may be ordered on a scale extending from soft to loud. Loudness is measured in **sones.**

Loudness depends primarily upon the **sound pressure** of the stimulus, but it also depends upon the frequency and waveform of the stimulus.

lower atmosphere. Generally, and quite loosely, that part of the atmosphere in which most weather phenomena occur (i.e., the **troposphere** and lower **stratosphere**); hence, used in contrast to the common meaning for the **upper atmosphere.**

lower branch. That half of a **meridian** or **celestial meridian** from pole to pole which passes through the antipode or **nadir** of a place.

lower culmination = lower transit.

lower limb. That half of the edge of the apparent disk of a **celestial body** having the least **altitude;** in contrast with the upper limb, that half having the greatest altitude.

lower transit. Transit of the **lower branch** of the **celestial meridian.** Also called *inferior transit, lower culmination.*

low frequency (*abbr* **LF**). See **frequency bands.**

low-pass filter. A **wave filter** having a single transmission band extending from zero **frequency** up to some critical or bounding frequency, not infinite.

low vacuum. The condition in a gas-filled space at pressures less than 760 torr and greater than some lower limit. It is recommended that this lower limit be chosen as 25 torr corresponding approximately to the **vapor pressure** of water at 25° C and to 1 inch of mercury.

The following classification scheme has been proposed for the pressure range from 760 to 10^{-3} torr:

Condition	*Pressure Range*
low vacuum	760 to 25 torr
medium vacuum	25 to 10^{-3} torr
rough vacuum	760 to 1 torr (torr range)
fine vacuum	1 to 10^{-3} torr (millitorr range)

lox. 1. Liquid oxygen. Used attributively as in *lox tank, lox unit.* Also called *loxygen.* **2.** To load the fuel tanks of a rocket vehicle with liquid oxygen. Hence, loxing.

lox-hydrogen engine. An engine using liquid hydrogen as **fuel** and liquid oxygen as **oxidizer.**

loxing. See **lox.**

loxygen = lox.

loz. Liquid ozone.

LP (*abbr*) = ***l**iquid **p**ropellant.*

L-scan = L-display.

L-scope = L-display.

lumen. A unit of **luminous flux** equal to the luminous flux radiated into a unit solid angle (steradian) from a point source having a **luminous intensity** of 1 candela.

An ideal source possessing an intensity of 1 candela in every direction would radiate a total of 4π lumens.

luminance. In photometry, a measure of the intrinsic **luminous intensity** emitted by a source in a given direction; the **illuminance** produced by light from the source upon a unit surface area oriented normal to the line of sight at any distance from the source, divided by the solid angle subtended by the source at the receiving surface. Also called *brightness* but *luminance* is preferred. See **Lambert law.** Compare **luminous emittance.**

It is assumed that the medium between source and receiver is perfectly transparent; therefore, luminance is independent of **extinction** between source and receiver. The source may or may not be self-luminous.

Luminance is a measure only of light; the comparable term for electromagnetic radiation in general is *radiance.*

luminance contrast. See **contrast,** sense **2.**

luminescence. Light **emission** by a process in which kinetic heat energy is not essential for the mechanism of **excitation.**

Electroluminescence is luminescence from electrical discharges—such as sparks or arcs. Excitation in these cases results mostly from electron or ion collision by which the kinetic energy of electrons or ions, accelerated in an electric field, is given up to the atoms or molecules of the gas present and causes light emission. *Chemiluminescence* results when energy, set free in a chemical reaction, is converted to light energy. The light from many chemical reactions and from many flames is of this type. *Photoluminescence,* or *fluorescence,* results from excitation by absorption of light. The term *phosphorescence* is usually applied to luminescence which continues after excitation by one of the above methods has ceased. Compare **incandescence.**

luminosity = luminous efficiency.

luminous. 1. In general, pertaining to the **emission** of **visible radiation. 2.** In photometry, a modifier used to denote that a given physical quantity, such as **luminous emittance,** is weighted according to the manner in which the response of the human eye varies with the wavelength of the light. See **luminous efficiency.**

luminous clouds = noctilucent clouds.

luminous density. The instantaneous amount of **luminous energy** contained in a unit volume of the propagating medium; to be distinguished from **radiant density** in that it is weighted in accordance with the characteristics of the human eye in its nonuniform response

to different wavelengths of light. See **luminous efficiency.** Compare **flux density, illuminance.**

luminous efficiency. For a given wavelength of **visible radiation,** the ratio of the **flux** that is effectively sensed by the human eye to the flux that is intrinsic in the **radiation.** It may be represented as a dimensionless ratio, e.g., lumens per watt. Also called *luminosity.*

Thus, luminous efficiency is a weighting factor which is applied to radiation quantities so that they are related physiologically to the response of the human eye, which varies as a function of wavelength. All quantities which are weighted in this manner should be modified by the term *luminous* (e.g., luminous emittance, luminous flux, etc.)

luminous emittance. The **emittance** of **visible radiation** weighted to take into account the different response of the human eye to different wavelengths of light. See **luminous efficiency.**

In photometry, *luminous emittance* is always used as a property of a self-luminous source, and therefore should be distinguished from *luminance.*

luminous energy (*symbol Q*). The **energy** of **visible radiation,** weighted in accordance with the wavelength dependence of the response of the human eye. See **luminous efficiency.** Also called *light energy.*

luminous flux (*symbol F*). **Luminous energy** per unit time; the **flux** of **visible radiation,** so weighted as to account for the manner in which the response of the human eye varies with the wavelength of radiation. See **luminous efficiency.**

The basic unit for luminous flux is the **lumen.**

luminous flux density. See **illuminance.**

luminous intensity. Luminous energy per unit time per unit solid angle; the **intensity** (flux per unit solid angle) of **visible radiation** weighted to take into account the variable response of the human eye as a function of the wavelength of light; usually expressed in **candles.** Also called *candlepower, light intensity.* Compare **luminance, illuminance.** See **luminous efficiency, light intensity.**

lunar. Of or pertaining to the moon.

lunar atmospheric tide. An **atmospheric tide** due to the **gravitational** attraction of the moon. The only detectable components are the 12-lunar-hour or semidiurnal, as in the oceanic tides, and two others of very nearly the same period. The amplitude of this atmospheric tide is so small that it is detected only by careful statistical analysis of a long record, being about 0.06 millibar in the tropics and 0.02 millibar in the middle latitudes. See **tide.**

lunar crater. A depression, usually circular, on the surface of the moon, usually with a raised rim called a **ringwall.**

Craters range in size up to 250 kilometers in diameter. The largest craters are sometimes called *walled plains.* The smaller, 15 to 30 kilometers across, are often called *craterlets* and the very smallest, a few hundred meters across, *beads.*

Craters are named after people, mainly astronomers.

lunar cycle. Any **cycle** related to the moon, particularly the **Callippic cycle** or the **Metonic cycle.** See **saros.**

lunar day. 1. The duration of one **rotation** of the earth on its axis, with respect to the moon. Its average length is about 24 hours 50 minutes of **mean solar time.** Also called *tidal day.* **2.** The duration of one **rotation** of the moon on its axis, with respect to the sun.

lunar distance. The angle, at an observer on the earth, between the moon and another **celestial body.**

This was the basis of a method formerly used to determine longitude at sea.

lunar eclipse. The phenomenon observed when the moon enters the shadow of the earth.

A lunar eclipse is called **penumbral** if the moon enters only the penumbra of the earth, *partial* if the moon enters the **umbra** without being totally immersed, and *total* if the moon is entirely immersed in the umbra.

lunar equation. A factor used to reduce observations of the positions of **celestial bodies** to the **barycenter** of the earth-moon system.

lunar gravity. The force imparted by the moon to a mass which is at rest relative to the moon. It is approximately $\frac{1}{6}$ of the earth's **gravity.**

lunar inequality. Variation in the moon's motion in its **orbit,** due to attraction by other bodies of the solar system. See **evection, perturbation.**

lunar interval. The difference in time between the **transit** of the moon over the **Greenwich meridian** and a **local meridian.**

lunar month. The period of **revolution** of the moon about the earth, especially a **synodical month.**

lunar noon. The instant at which the sun is over the **upper branch** of any **meridian** of the moon.

lunar orbit. Orbit of a **spacecraft** around the moon.

lunar parallax. The **horizontal parallax** or the **geocentric parallax** of the moon.

lunar probe. A **probe** for exploring and reporting on conditions on or about the moon.

lunar satellite. A manmade **satellite** that would make one or more **revolutions** about the moon. See **selenoid.**

lunar time. 1. Time based upon the **rotation** of the earth relative to the moon. Lunar time

may be designated as **local** or **Greenwich** as the local or Greenwich meridian is used as the reference. **2.** Time on the moon.

lunation = **synodical month.**

lune. That part of the surface of a **sphere** bounded by halves of two **great circles.**

lunicentric = **selenocentric.**

Lunik. Russian term for a space **probe** launched to the moon's vicinity or to **impact** on the moon.

lunisolar precession. That component of **general precession** caused by the combined effect of the sun and moon on the equatorial protuberance of the earth, producing a westward motion of the equinoxes along the **ecliptic.** See **precession of the equinoxes.**

Lup, Lupi. International Astronomical Union abbreviations for *Lupus.* See **constellation.**

Lupus (*abbr* **Lup, Lupi**). See **constellation.**

lusec. A unit of **flow** rate equal to 1 micron liter per second.

lux. A photometric unit of **illuminance** or **illumination** equal to 1 **lumen** per square meter. Compare **foot-candle, phot.**

Lyman-alpha radiation. The radiation emitted by hydrogen at 1216 angstrom, first observed in the solar spectrum by rocket-borne spectrographs.

Lyman-alpha radiation is very important in the heating of the upper atmosphere thus affecting other atmospheric phenomena.

Lyn, Lync. International Astronomical Union abbreviations for *Lynx.* See **constellation.**

Lynx (*abbr* **Lyn, Lync**). See **constellation.**

Lyr, Lyra. International Astronomical Union abbreviations for *Lyra.* See **constellation.**

Lyra (*abbr* **Lyr, Lyra**). See **constellation.**

M

Mach = Mach number.

Some writers use *Mach* as a unit of speed equivalent to a Mach number of 1.00, as *a speed of Mach 3.1.*

Mach angle. The angle between a **Mach line** and the direction of movement of undisturbed flow. See **Mach wave.**

Mach cone. **1.** The cone-shaped **shock wave** theoretically emanating from an infinitesimally small particle moving at supersonic speed through a fluid medium. It is the locus of the **Mach lines.** **2.** The cone-shaped shock wave generated by a sharp-pointed body, as at the nose of a high-speed aircraft. See **Mach wave.**

Mach indicator = Machmeter.

machine error. See **error,** note.

machine language. **1.** A **language,** occurring within a **computer,** ordinarily not perceptible or intelligible to persons without special equipment or training. **2.** A translation or transliteration of sense **1** into more conventional **characters** but frequently still not intelligible to persons without special training.

machine word. For a given **computer,** the number of information **characters** handled in each transfer. This number is usually fixed, but may be variable in some computers.

Mach line. A line representing a **Mach wave;** a Mach wave.

Machmeter. An instrument that measures and indicates speed relative to the **speed of sound,** i.e., that indicates the **Mach number.** Also called *Mach indicator.*

Mach number (*symbols* M, N_{Ma}). (Pronounced *mock,* after Ernst Mach, 1838–1916, Austrian scientist.) A number expressing the ratio of the speed of a body or of a point on a body with respect to the surrounding air or other **fluid,** or the speed of a **flow,** to the **speed of sound** in the medium; the speed represented by this number. See **Cauchy number.**

If the Mach number is less than 1, the flow is called *subsonic* and local disturbances can propagate ahead of the flow. If the Mach number is greater than 1, the flow is called *supersonic* and disturbances cannot propagate ahead of the flow with the result that shock waves form.

Some authorities use *mach number* but engineering practice is to use a capital *M* in all words and combinations employing *Mach.*

Mach wave. **1.** A **shock wave** theoretically occurring along a common line of intersection of all the pressure disturbances emanating from an infinitesimally small particle moving at supersonic speed through a **fluid** medium, with such a wave considered to exert no changes in the condition of the fluid passing through it.

The concept of the Mach wave is used in defining and studying the realm of certain disturbances in a supersonic field of flow.

2. A very weak shock wave appearing, e.g., at the nose of a very sharp body, where the fluid undergoes no substantial change in direction.

Maclaurin series. See **Taylor theorem.**

macroscopic. Large enough to be visible to the naked eye or under low order of magnification.

macrosonics. The technology of **sound** at signal amplitudes so large that **linear** approximations are not valid.

magic tee. A compound **waveguide** or coaxial tee with four arms which exhibits directional characteristics, when properly matched, so that a **signal** entering one arm will be split between two of the other arms but not the third. A signal entering another arm is likewise split with half the energy entering one of the arms common to the other input but not its second arm and the other half of the energy entering the arm not used by the other input.

The magic tee is used in radar as a transmitter-receiver **duplexer.**

magnesyn. (A trade name, from *magne*tic + *syn*chronous; often capitalized.) An electromagnetic device that transmits the direction of a **magnetic field** from one coil to another, used to transmit measurements electrically from a point of measurement to an **indicator** in a remote-indicating system.

magnet. A body which produces a **magnetic field** around itself.

magnetic. **1.** Of or pertaining to a magnet. **2.** Of or pertaining to a material which is capable of being magnetized. **3.** Related to or measured from magnetic north.

magnetic bay. A small magnetic disturbance whose **magnetograph** resembles an indentation of a coastline.

On earth, magnetic bays occur mainly in the polar regions and have durations on the order of a few hours.

magnetic binary core = binary magnetic core.

magnetic character figure = **C-index.**

magnetic core = **binary magnetic core.**

magnetic crotchet. A sudden change in the earth's **magnetic field** due to an increase in the conductivity of the lower ionosphere. See **sudden ionospheric disturbance.**

magnetic current sheath. See **plasma sheath.**

magnetic declination (*symbol* D, δ). In **terrestrial magnetism;** at any given location, the angle between the **geographical meridian** and the **magnetic meridian;** that is, the angle between true north and magnetic north. Also called *declination*, and in navigation, *variation.*

Declination is either *east* or *west* according as the compass needle points to the east or west of the geographical meridian.

Lines of constant declination are called *isogonic lines* and the one of zero declination is called the *agonic line.*

magnetic deviation. The angle between the **magnetic meridian** and the axis of a compass card, expressed in degrees east or west to indicate the direction in which the northern end of the compass card is offset from **magnetic north.** Also called *deviation.* Compare **variation.**

magnetic dip (*symbol* i). The angle between the **horizontal** and the direction of a line of force of the earth's **magnetic field** at any point. Also called *magnetic inclination, magnetic latitude, inclination, dip.*

magnetic dipole moment = **magnetic moment.**

magnetic disturbance daily variation (*symbol* S_D). A periodic variation of the earth's **magnetic field** that is in phase with solar (**local**) time. It is the difference between the solar daily variation (or the disturbed-day solar daily variation) and the quiet-day solar daily variation. This variation is primarily an effect of enhanced electromagnetic radiation during increased solar activity.

magnetic disturbed-day solar daily variation (*symbol* S_d). The **solar daily variation** of the earth's magnetic field obtained from the 5 most disturbed days of the month.

magnetic double refraction. The splitting, into two components, of a **radio wave** traveling in a region of **free electrons.** This is due to the interaction of the earth's **magnetic field** and the alternating field of the radio wave. Except for waves near the **gyrofrequency,** the components of the split wave, the ordinary ray and the extraordinary ray, will travel with slightly different velocities and be reflected at different heights. See **magneto-ionic theory.**

magnetic drum. A memory device used in **computers;** a rotating cylinder on which information may be stored as magnetically polarized areas, usually along several parallel tracks around the periphery.

magnetic element. **1.** In **terrestrial magnetism,** any of the following measurements: the vector magnetic field, also called *total field* (*symbol* $\vec{F}$); the scalar intensity of the total field (*symbol* F); declination, also called *variation* (*symbol* D); the intensity of the horizontal component of the earth's field (*symbol* H); the intensity of the vertical component (*symbol* Z), taken as positive downward; the inclination or dip (*symbol* I); the angle between $\vec{F}$ and H; the intensity of the component of the horizontal field in the geographic north direction (*symbol* X); and the intensity of the component of the horizontal field in the geographic east direction. **2.** That part of an instrument producing or influenced by magnetism.

magnetic equator. That line on the surface of the earth connecting all points at which the **magnetic dip** is zero. Also called *aclinic line.* See **geomagnetic equator.**

magnetic equivalent amplitude indices. A linear measure of geomagnetic disturbance activity, based on the K-indices that gives an equivalent amplitude of the magnetic disturbance for the 3-hour period denoted by a_p. A daily index A_p is defined as the average of the a_p value over the 8 values of the day. See **magnetic K-indices.**

magnetic field. **1.** A region of space wherein any magnetic **dipole** would experience a magnetic force or torque; often represented as the geometric array of the imaginary **magnetic lines of force** that exist in relation to magnetic poles. **2.** = **magnetic field intensity.**

magnetic field intensity. The magnetic force exerted on an imaginary unit **magnetic pole** placed at any specified point of space. It is a vector quantity. Its direction is taken as the direction toward which a north magnetic pole would tend to move under the influence of the field. If the force is measured in dynes and the unit pole is a cgs unit pole, the field intensity is given in **oersteds.** Also called *magnetic intensity, magnetic field, magnetic field strength.*

Prior to 1932 the oersted was called the *gauss;* but the latter term is now used to measure magnetic induction (within magnetic materials), whereas oersted is reserved for magnetic force. By definition, one magnetic line of force per square centimeter (in air) represents the field intensity of 1 oersted.

magnetic field strength = magnetic field intensity.

magnetic giant pulsations. **Magnetic micropulsations** having large amplitudes.

magnetic inclination = magnetic dip.

magnetic induction. A measure of the strength of a **magnetic field** existing within a magnetic medium.

The relation between the magnetic induction and magnetic field intensity is such that the magnetic induction within a small mass of material of magnetic permeability μ is, except for possible hysteresis effects, μ times greater than the external magnetic field intensity. Whereas magnetic field intensity is measured in **oersteds,** magnetic induction is measured in **gausses.**

magnetic intensity = magnetic field intensity.

magnetic K-indices. An approximately logarithmic measure of geomagnetic disturbance activity based on the range of the most disturbed **magnetic element** during each 3-hour interval of the day. The K-indices are assigned integers from 0 to 9.

The K-indices averaged over the observatories of the earth are called *planetary indices* K_p and divided into 28 grades.

magnetic latitude = magnetic dip. See **geomagnetic latitude.**

magnetic lines of force. Imaginary lines so drawn in a region containing a **magnetic field** to be everywhere tangent to the **magnetic field intensity** vector if in vacuum or nonmagnetic material, or parallel to the **magnetic induction** vector if in a magnetic medium. See **electric lines of force.**

As so defined, these lines of force are merely convenient artifices for delineating the geometry of a magnetic field. They are given quantitative significance in magnetic theory by associating one line of force per square centimeter normal to the force for every oersted of field intensity (in vacuum), for every gauss of magnetic induction (in magnetic media).

magnetic lunar daily variation (*symbol L*). A periodic variation of the earth's **magnetic field** that is in phase with the transit of the moon.

This variation is essentially a tidal effect. The amplitude of this variation changes with the phase of the moon, the seasons, and the sunspot cycle.

magnetic memory. **1.** The ability of a material to retain magnetism after the magnetizing force is removed. **2. = magnetic storage.**

magnetic meridian. The horizontal line which is oriented, at any specified point on the earth's surface, along the direction of the horizontal component of the earth's **magnetic field** at that point; not to be confused with **isogonic line.** Also called *geomagnetic meridian.* Compare **isoclinic line, magnetic equator.**

magnetic micropulsations. Oscillations in magnetic records having **periods** of between a fraction of a minute and a few minutes, lasting for an hour or so.

magnetic mirror. A **magnetic field** so arranged that it will theoretically confine a hot **plasma.**

magnetic moment. **1.** The quantity obtained by multiplying the distance between two **magnetic poles** by the average strength of the poles. **2.** A measure of the magnetic **flux** set up by the gyration of an electric charge in a **magnetic field.** The moment is negative, indicating it is diamagnetic, and equal to the energy of rotation divided by the magnetic field. **3.** (*symbol* **m**). In atomic and nuclear physics, a moment, measured in **Bohr magnetons,** associated with the intrinsic spin of the particle and with the orbital motion of the particle in a system. Also called *magnetic dipole moment.*

magnetic north. The direction north at any point as determined by the earth's **magnetic lines of force;** the reference direction for measurement of magnetic directions.

magnetic pole. **1.** Either of the two places on the surface of the earth where the **magnetic dip** is 90°, that in the Northern Hemisphere (at, approximately, latitude 73° 8 N, longitude, 101° W in 1955) being designated *north magnetic pole,* and that in the Southern Hemisphere (at, approximately, latitude, 68° S, longitude, 144° E in 1955) being designated *south magnetic pole.* Also called *dip pole.* See **geomagnetic latitude, geomagnetic pole, magnetic latitude.** **2.** Either of those two points of a **magnet** where the magnetic force is greatest. **3.** In magnetic theory, a fictitious entity analogous to a unit electric charge of electrostatic theory. In nature only **dipoles,** not isolated magnetic poles, exist.

magnetic pressure. The energy density associated with a **magnetic field.**

In a very real sense, there is energy stored in a magnetic field, and since energy per unit volume is equivalent to force per unit area or pressure, one may speak of the *pressure* exerted by a magnetic field. For plasma containment in a thermonuclear device, the magnetic pressure must be greater than the kinetic pressure of the plasma. See **beta factor.** A pressure of 1 atmosphere corresponds approximately to 5,000 gausses, and the pressure is proportional to the square of the field.

magnetic quiet-day solar daily variation (*symbol* S_q). The **magnetic solar daily variation** obtained from the 5 most quiet days of the month.

magnetic solar daily variation (*symbol S*). A periodic variation of the earth's **magnetic field** that is in phase with solar (**local**) time.

The primary source of this variation is the ionizing effect of solar electromagnetic radiation on the atmosphere coupled with the earth's rotation. The amplitude of this variation changes with the seasons and the sunspot cycle.

magnetic storage. In computer terminology, any device which makes use of the **magnetic** properties of materials for the storage of information.

magnetic storm. A worldwide disturbance of the earth's **magnetic field.** See **M-region.**

Magnetic storms are frequently characterized by a sudden onset, in which the magnetic field undergoes marked changes in the course of an hour or less, followed by a very gradual return to normality, which may take several days. Magnetic storms are caused by solar disturbances, though the exact nature of the link between the solar and terrestrial disturbances is not understood. They are more frequent during years of high sunspot number. Sometimes a magnetic storm can be linked to a particular solar disturbance. In these cases, the time between solar flare and onset of the magnetic storm is about 1 or 2 days, suggesting that the disturbance is carried to the earth by a cloud of particles thrown out by the sun.

When these disturbances are observable only in the auroral zones, they may be termed *polar magnetic storms.*

magnetic storm-time variation (*symbol* D_{st}). A nonperiodic variation determined from the onset of a **magnetic storm.** This variation is characterized by a rapid increase of the magnetic horizontal intensity above the normal value, remaining so for a few hours and then rapidly decreasing to below the normal value and remaining so for periods up to several days. The intensity then returns slowly to the normal value.

magnetic tape. A ribbon of paper, metal, or plastic, coated or impregnated with **magnetic** material on which information may be stored in the form of magnetically **polarized** areas.

magnetic variation. **1. Variation,** definition **1.** **2.** Change in a **magnetic element.**

magnetic wire. Wire made of **magnetic** material on which information may be stored in the form of magnetically **polarized** areas.

magnetoelectric. Of or pertaining to electricity produced by or associated with **magnetism.**

Electromagnetic pertains to magnetism produced by or associated with electricity.

magnetoelectric transducer. A **transducer** which measures the electromotive force generated by the movement of a conductor relative to a **magnetic field.**

magnetofluiddynamics = **magnetohydrodynamics.**

magnetogasdynamics = **magnetohydrodynamics.**

magnetograph. The trace of an instrument recording variations in the **geomagnetic field.**

magnetohydrodynamics (*abbr* **MHD**). The study of the interaction that exists between a **magnetic field** and an electrically conducting **fluid.** Also called *magnetoplasmadynamics, magnetogasdynamics, hydromagnetics.*

magnetohydrodynamic wave = **Alfvén wave.**

magnetoionic theory. The theory of propagation of **electromagnetic radiation** through a medium containing **ions** in the presence of an external **magnetic field.**

It applies to the propagation of radio waves in the ionosphere, and provides theoretical relationships among such aspects of the subject as the index of refraction, radiofrequency, free-electron density, electron collision frequency, the earth's magnetic field (components relative to the direction of propagation), the nature of polarization, etc. See **magnetic double refraction.**

magnetoionic wave component. Either of the two elliptically polarized wave components into which a linearly polarized **electromagnetic wave,** incident on the **ionosphere,** is separated because of the earth's **magnetic field.**

magnetometer. An instrument used in the study of **geomagnetism** for measuring a **magnetic element.**

magneton. See **Bohr magneton.**

magnetoplasmadynamics = **magnetohydrodynamics.**

magnetosphere. The region of the earth's atmosphere where ionized gas plays an important part in the dynamics of the atmosphere and where the geomagnetic field, therefore, plays an important role. The magnetosphere begins, by convention, at the maximum of the ***F* layer** at about 350 kilometers and extends to 10 or 15 earth radii to the boundary between the atmosphere and the interplanetary **plasma.**

magnetostriction. **1.** The phenomenon wherein **ferromagnetic** materials experience an elastic strain when subjected to an external **magnetic field.** **2.** The converse of sense **1** in which mechanical stresses cause a change in the **magnetic induction** of a ferromagnetic material.

magnetostrictive delay line. In electronic computers, a device in which a wave is induced by the characteristic, possessed by nickel and certain other materials, of shortening in length when placed in a magnetic field. The wave travels at the **speed of sound** through the material. See **delay line.**

magnetron. An **electron tube** characterized by the interaction of electrons with the electric field of a circuit **element** in crossed steady electric and magnetic **fields** to produce alternating-current power output.

magnitude (*symbol* m). **1.** The relative **lumi-**

nance of a celestial body. The smaller (algebraically) the number indicating magnitude, the more luminous the body. Also called *stellar magnitude*. See **absolute magnitude.**

The ratio of relative luminosity of two celestial bodies differing in magnitude by 1.0 is 2.512, the fifth root of 100.

Decrease of light by a factor of 100 increases the stellar magnitude by 5.00; hence, the brightest objects have negative magnitudes (Sun: −26.8; mean full moon: −12.5; Venus at brightest: −4.3; Jupiter at opposition: −2.3; Sirius: −1.6; Vega: 0.2; Polaris: 2.1). The faintest stars visible to the naked eye on a clear dark night are of about the sixth magnitude (though on a perfectly black background the limit for a single luminous point approaches the eighth magnitude). The faintest stars visible with a telescope of aperture a (in inches) is one approximately of magnitude $9 + 5 \log_{10} a$. The magnitude of the faintest stars which can be photographed with the 200-inch telescope is about +22.7.

The expression *first magnitude* is often used somewhat loosely to refer to all bodies of magnitude 1.5 or brighter, including negative magnitudes.

2. Amount; size; greatness. See **order of magnitude.**

main bang. The transmitted **pulse,** within a **radar** system.

main stage. 1. In a multistage rocket, the **stage** that develops the greatest amount of **thrust,** with or without **booster engines. 2.** In a **single-stage rocket** vehicle powered by one or more engines, the period when full thrust (at or above 90 percent) is attained. **3.** A **sustainer engine,** considered as a stage after booster engines have fallen away, as in *the main stage of the Atlas.*

major axis. The longest diameter of an **ellipse** or **ellipsoid.**

major lobe. See **lobe.**

major planets. The four largest **planets:** Jupiter, Saturn, Uranus, and Neptune.

malfunction. Improper functioning of a **component,** causing improper operation of a **system.**

man-machine integration. The matching of the characteristics and capabilities of man and machine in order to obtain optimum conditions and maximum efficiency of the combined **system.** See **man-machine system.**

man-machine system. A **system** in which the functions of the man and the machine are interrelated and necessary for the operation of the system.

manned. Of a **vehicle** occupied by one or more persons who normally have control over the movements of the vehicle, as in a manned aircraft or spacecraft, or who perform some useful function while in the vehicle.

manometer. An instrument for measuring pressure of gases and vapors both above and below **atmospheric pressure.** See **vacuum gage.**

manometric equivalent. The length in millimeters of a vertical column of a given liquid at standard room temperature equivalent to 1 millimeter of mercury at 0° C.

many-to-few matrix = decoder.

map-matching guidance. 1. The **guidance** of a rocket or aerodynamic vehicle by means of a **radarscope** film previously obtained by a reconnaissance flight over the terrain of the route, and used to direct the vehicle by alining itself with radar **echoes** received during flight from the terrain below. **2.** Guidance by **stellar map matching.**

March equinox = vernal equinox.

mare. (*pl.* **maria**) Latin for sea. The large, dark, flat areas on the lunar surface, thought by early astronomers to be bodies of water. The term is also applied to less well-defined areas on Mars.

Mariotte law = Boyle-Mariotte law.

marmon clamp. A ring-shaped clamp, consisting of three equal length segments held together by **explosive bolts,** used to couple the main subsections of a rocket vehicle.

marriage = mating.

Mars. See **planet,** table.

maser. An **amplifier** utilizing the principle of *m*icrowave *a*mplification by *s*timulated *e*mission of *r*adiation. **Emission** of energy stored in a molecular or atomic system by a **microwave** power supply is stimulated by the **input signal.**

mass (*symbol* m). A quantity characteristic of a body, which relates the attraction of this body toward another body. Since the mass of a body is not fixed in magnitude, all masses are referred to the standard kilogram, which is a lump of platinum.

Mass of a body always has the same value; *weight* changes with change in the acceleration of gravity.

mass-charge ratio. The ratio of the **mass number** of an element to the number of **electronic charges** gained or lost in ionization.

mass density (*symbol* ρ). **Mass** per unit volume.

mass-energy equivalence. The equivalence of a quantity of **mass** m and a quantity of **energy** E, the two quantities being related by the mass-energy relation, $E = mc^2$.

This relation was proposed by Einstein as a consequence of his restricted (or special) theory of relativity; it has subsequently received abundant experimental confirmation and is regarded as a general law. The factor c^2 may be regarded as the conversion factor relating units of energy and mass; various useful forms of this factor are: $c^2 = (2.998 \times 10^{10})^2$ centimeters per second =

8.987 × 10^{22} ergs per gram = 931.1 million electron volts per atomic mass unit.

See **relativity.**

mass flow rate per unit area (*symbol* G). In **aerodynamics,** the product of **fluid** density ρ and the linear velocity of the fluid v or

$$G = \rho v$$

mass number. The whole number nearest the value of the atomic **mass** of an **element** as expressed in **atomic mass units.**

The mass number is assumed to represent the total number of protons and neutrons in the atomic nucleus of the element and is therefore equal to the atomic number plus the number of the neutrons. The mass number of an atom is usually written as a superscript to the element symbol, as in O^{18}, an isotope of oxygen with mass number 18.

mass ratio. The ratio of the mass of the **propellant** charge of a **rocket** to the total mass of the rocket when charged with the propellant.

mass-velocity ratio. A quantity m_v/m_r expressing the relativistic variation of *mass* with *velocity*.

$$m_v = m_r \left[\sqrt{1 - (v^2/c^2)}\right]$$

where m_v is moving mass, m_r is rest mass, v is velocity, and c is the velocity of light.

This ratio becomes important only at speeds approaching the speed of light.

master station. In a **hyperbolic navigation system,** such as **loran,** that transmitting station which controls the transmissions of another station or of other stations. See **hyperbolic navigation, slave station.**

Mate (*abbr*). ***M*odular *a*utomatic *t*est *e*quipment.**

mate. To fit together two major **components** of a **system.** Also called *marry.*

material coordinates = Lagrangian coordinates.

material derivative = individual derivative.

materials. In general, the substances of which rockets and space vehicles are composed; specifically, the metals, alloys, ceramics, and plastics used in structural, protective, and electronic functions.

mating. 1. The act of fitting together two major **components** of a **system** as *mating of a launch vehicle and a spacecraft.* Also called *marriage.* **2. = interface.**

matrix. 1. Any rectangular array of elements composed of rows and columns; specifically, such an array consisting of numbers or mathematical symbols which can be manipulated according to certain rules. **2.** In electronic **computers,** any logical **network** whose configuration is a rectangular array of intersections of its input-output leads, with elements connected at some of these intersections. The network usually functions as an **encoder** or **decoder.** Loosely, any encoder, decoder, or **translator.**

Matts (*abbr*) = ***m*ultiple *a*irborne *t*arget *t*rajectory *s*ystem.**

maximum energy density. See **sound-energy density.**

maximum evaporation rate. The maximum rate at which **molecules** could emerge from a surface, deduced from measurements of saturated **vapor pressure** at the same temperature. Also called *Knudsen rate of evaporation* or *Langmuir rate of evaporation.*

maximum sound pressure. For any given **cycle** of a periodic **wave,** the maximum absolute value of the instantaneous **sound pressure,** without regard to sign, occurring during that cycle. The unit is the microbar.

In the case of a sinusoidal sound wave, the maximum sound pressure is also called the *pressure amplitude.*

maximum usable frequency (*abbr* **MUF**). For a given distance from a **transmitter,** the highest **frequency** at which **sky waves** can be received.

Maxwellian distribution. The velocity distribution, as computed in the **kinetic theory of gases,** of the molecules of a gas in thermal equilibrium.

This distribution is often assumed to hold for **neutrons** in thermal equilibrium with the **moderator** (thermal neutrons).

McLeod gage. A liquid-level **vacuum gage** in which a known volume of a gas, at the **pressure** to be measured, is compressed by the movement of a liquid column to a much smaller known volume, at which the resulting higher pressure is measured.

Particular designs are named after the inventors or by various trade names.

M-curve. A plot of values of M-units (**modified index of refraction**) as a function of height in an atmosphere. M-curves are frequently used in **ray tracing** studies.

MCW (*abbr*) = ***m*odulated *c*ontinuous *w*ave.**

M-display. In radar, a display in which target distance is determined by moving an adjustable **blip** along the baseline until it coincides with the horizontal position of the **target** signal deflections. The control which moves the blip is calibrated in distance. Also called *M-scan, M-scope, M-indicator.*

mean = arithmetic mean.

mean anomaly. See **anomaly.**

mean center of moon. A central point for a lunar coordinate system; the point on the lunar surface intersected by the lunar radius that is directed toward the earth's center when the moon is at the mean ascending node and when the node coincides with the *mean perigee* or *mean apogee*.

mean deviation = average deviation.

mean distance = semimajor axis.

mean equinox. A fictitious equinox whose position is that of the **vernal equinox** at a particular date with the effect of **nutation** removed. Also called *mean equinox of date*.

mean equinox of date = mean equinox.

mean error = root-mean-square error.

mean free path (*symbol* l, λ, L). **1.** Of any **particle,** the average distance that a particle travels between successive collisions with the other particles of an ensemble.

In vacuum technology, the ensemble of particles of interest comprises only the molecules in the gas phase.

2. Specifically, the average distance traveled by the **molocules** of a **perfect gas** between consecutive collisions with one another. It may be determined roughly from either of the formulas

$$l = 3\mu/\rho c = 3\nu/c$$

or

$$l = 1/\sqrt{2\pi}\, nd^2$$

where l is the mean free path; μ is the dynamic viscosity; ν is the kinematic viscosity; ρ is the density; c is the molecular speed (a function of the gas temperature); n is the number of molecules per unit volume; and d is the molecule diameter.

Given the mean free path l_0 at a level where the pressure is p_0, the temperature is T_0 (°K), and the acceleration of gravity is g_0, then its value at any other level is

$$l = l_0 p_0 T g / p T_0 g_0$$

where p, T, and g are the pressure, temperature, and acceleration of gravity, respectively, at the new level. See **mixing length.**

3. For any process the reciprocal of the **cross section** per unit volume for that process.

mean motion (*symbol* n, μ). Of an object in **orbit,** a measure of angular velocity,

$$n = 2\pi/P$$

where P = period.

mean noon. The instant the mean sun is over the upper branch of the reference meridian; twelve o'clock **mean time.**

mean position. Of a star, the position on the **celestial sphere** computed from past observations plus known **proper motion** but not corrected for short term variations. See **Besselian star numbers.**

mean sea level. The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.

Mean sea level is the datum from which heights are measured. In this sense sometimes shortened to *sea level*. See **geoid.**

mean sidereal time. Sidereal time adjusted for **nutation** to eliminate slight irregularities in the rate.

mean solar day. The duration of one **rotation** of the earth on its axis, with respect to the **mean sun.**

The length of the mean solar day is 24 hours of mean solar time or 24 hours 3 minutes 56.555 seconds of mean sidereal time. A mean solar day beginning at midnight is called a *civil day*; and one beginning at noon, 12 hours later, is called an *astronomical day*. See **calendar day.**

mean solar second. Prior to 1960 the fundamental unit of time, equal to 1/86,400 of the **mean solar day.** Now replaced by the **ephemeris second.**

mean solar time. See **solar time.**

mean square. Referring to the **arithmetic mean** of the squares of the values under consideration, as *mean-square amplitude, mean-square error.*

mean-square error. The quantity whose square is equal to the sum of the squares of the individual **errors** divided by the number of those errors.

mean sun. A fictitious sun conceived to move eastward along the **celestial equator** at a rate that provides a uniform measure of time equal to the average **apparent time;** the reference for reckoning **mean time, zone time,** etc. See **dynamical mean sun.**

mean time. Time based upon the **rotation** of the earth relative to the **mean sun.**

Mean time may be designated as *local* or *Greenwich* as the local or Greenwich meridian is the reference. Greenwich mean time is also called *universal time*. Zone, standard, daylight saving or summer, and war time are also variations of mean time, specified meridians being used as the reference. Mean time reckoned from the upper branch of the meridian is called *astronomical time*. Mean time was called *civil time* in U.S. terminology from 1925 through 1952. See **equation of time, mean sidereal time.**

measurand. A physical quantity, force, property or condition which is to be measured. Also called *stimulus*.

mechanical equivalent of heat (*symbol* J) = **Joule constant.**

mechanical system. In the study of **vibration,** an aggregate of matter comprising a defined **configuration** of mass, mechanical stiffness, and mechanical resistance.

mechanoreceptor. A nerve ending that reacts

to mechanical stimuli, as touch, tension, and acceleration.

median. The middle term of a series, or the interpolated value of the two middle terms if the number of terms is even. Compare **mean.**

median lethal dose. The amount of **radiation** required to kill, within a specified period, 50 percent of the individuals of a group of animals or organisms.

medium frequency (*abbr* MF). See **frequency bands.**

mega (*abbr* M). A prefix meaning multiplied by 10^6.

megacycle. (*abbr* Mc, mc). One million cycles; one thousand kilocycles.

The term is often used as the equivalent of one million cycles per second.

megaparsec. One million parsecs. See **parsec.**

mel. A unit of **acoustic** pitch. By definition, a simple tone of **frequency** 1000 cycles per second, 40 decibels above a listener's threshold, produces a pitch of 1000 mels. The pitch of any sound that is judged by the listener to be n times that of a 1-mel tone is n mels.

membrane structure. A shell structure, often **pressurized,** that does not take wall bending or compression loads.

memory. The component of a **computer,** control system, guidance system, instrumented satellite, or the like, designed to provide ready access to data or instructions previously recorded so as to make them bear upon an immediate problem, such as the guidance of a physical object, or the analysis and reduction of data.

memory capacity. See **storage capacity.**

memory device. See **storage.**

Men, Mens. International Astronomical Union abbreviations for *Mensa.* See **constellation.**

Mensa (*abbr* Men, Mens). See **constellation.**

Mercury. See **planet,** table.

mercury memory. The retention of information by the propagation of a **sound wave** in liquid mercury.

meridian. A north-south reference line, particularly a **great circle** through the geographical poles of the earth. The term usually refers to the **upper branch,** that half, from pole to pole, which passes through a given place, the other half being called the *lower branch.* See **coordinate,** table.

A terrestrial meridian is a meridian of the earth. Sometimes designated *true meridian* to distinguish it from magnetic meridian, compass meridian, or grid meridian, the north-south lines relative to magnetic, compass, or grid direction, respectively. An astronomical meridian is a line connecting points having the same astronomical longitude. A geodetic meridian is a line connecting points of equal geodetic longitude. Geodetic and sometimes astronomical meridians are also called *geographic* meridians. Geodetic meridians are shown on charts. The prime meridian passes through longitude 0°. A fictitious meridian is one of a series of great circles or lines used in place of a meridian for certain purposes. A transverse or inverse meridian is a great circle perpendicular to a transverse equator. An oblique meridian is a great circle perpendicular to an oblique equator. Any meridian used as a reference for reckoning time is called a time meridian. The meridian through any particular place or observer, serving as the reference for local time, is called *local meridian,* in contrast with the Greenwich meridian, the reference for Greenwich time. A celestial meridian is a great circle of the celestial sphere, through the celestial poles and the zenith.

meridian angle. Angular distance east or west of the local **celestial meridian;** the arc of the **celestial equator,** or the angle at the celestial pole, between the **upper branch** of the local celestial meridian and the **hour circle** of a **celestial body,** measured eastward or westward from the local celestial meridian through 180°, and labeled E or W to indicate the direction of measurement. See **hour angle.**

meridian transit. See **transit.**

meridional. Referring to a meridian.

mesh. A set of **branches** forming a closed path in a **network,** provided that if any one branch is omitted from the set, the remaining branches of the set do not form a closed path.

The term *loop* is sometimes used in the sense of *mesh.*

meson. In the classification of **subatomic particles** by mass, the second lightest of such particles. Its mass is intermediate between that of the **lepton** and the **nucleon** (see **hyperon**).

Mesons are highly unstable, very short-lived particles; they carry positive, negative, or no charge, and, in a vacuum, move with velocities approaching the speed of light. All of these particles have extremely short lifetimes and the heavier more unstable mesons tend to decay into lighter ones.

mesopause. The base of the inversion at the top of the **mesosphere,** usually found at 80 to 85 kilometers. See **atmospheric shell.**

mesopeak. The temperature maximum at about 50 kilometers in the **mesosphere.** See atmospheric shell.

mesosphere. **1.** The **atmospheric shell,** in which temperature generally decreases with heights, extending from the **stratopause** at about 50 to 55 kilometers to the **mesopause** at about 80 to 85 kilometers. **2.** The atmospheric shell between the top of the **ionosphere** (the top of this region has never been clearly defined) and the bottom of the **exosphere.** (This definition has not gained general acceptance.)

message. **1.** An ordered selection from an

agreed set of symbols, intended to communicate **information.** 2. The original **modulating wave** in a communication system.

The term in sense 1 is used in communication theory; the term in sense 2 is often used in engineering practice.

metabolic reserves. The energy source stored in chemical form, such as carbohydrates, that can be efficiently mobilized and utilized by the body, particularly for muscular activity and work beyond the normal level of activity of an individual.

metachemical. Pertaining to the chemistry of **subatomic particles.**

metagalaxy. The entire system of galaxies including the **Milky Way.**

metallic fuels. Of or pertaining to **nuclear fuels** which are a mixture, a pressed powder, or an alloy of a **fissionable** material, such as uranium-235 or plutonium-239, and a metal such as aluminum, zirconium, or stainless steel.

metastable atom. An **atom** with an electron excited to an **energy level** where simple radiation is forbidden and thus the atom is momentarily stable. See **forbidden line.**

The presence of these metastable atoms in a discharge is the cause of several anomalous effects since in essence they are storing energy which can be released to other particles upon collision. The **Penning effect** is a result of the presence of metastable atoms.

metastable compound. A chemical compound of comparative stability which, however, becomes unstable under a particular set of conditions.

metastable propellant. A **metastable compound** used as a **propellant.**

Nitromethane (CH_3NO_2), for example, may be used as a monopropellant at chamber pressure above 500 pounds per square inch. At lower pressure, it requires an oxidizer for stable combustion.

meteor. In particular, the light phenomenon which results from the entry into the earth's atmosphere of a solid particle from space; more generally, any physical object or phenomenon associated with such an event. See **meteoroid.**

meteoric. Of or pertaining to **meteors** and **meteoroids.**

meteorite. Any **meteoroid** which has reached the surface of the earth without being completely vaporized.

meteoritic. Of or pertaining to **meteorites.**

meteoritics. The study of **meteorites** and **meteoric** and **meteoritic** phenomena.

meteoroid. A solid object moving in interplanetary space, of a size considerably smaller than an **asteroid** and considerably larger than an atom or molecule.

meteorological optics = atmospheric optics.

meteorological rocket. A **rocket** designed primarily for routine **upper air observation** (as opposed to research) in the lower 250,000 feet of the atmosphere, especially that portion inaccessible to balloons, i.e., above 100,000 feet. Also called *rocketsonde.*

meteorology. The study dealing with the phenomena of the **atmosphere.** This includes not only the physics, chemistry, and dynamics of the atmosphere, but is extended to include many of the direct effects of the atmosphere upon the earth's surface, the oceans, and life in general.

A distinction can be drawn between meteorology and climatology, the latter being primarily concerned with average, not actual, weather conditions. Meteorology may be subdivided, according to the methods of approach and the applications to human activities, into a large number of specialized sciences. The following are of interest to space science: **aerology, aeronomy, dynamic meteorology, physical meteorology, radio meteorology.**

meteor path. The projection of the **trajectory** of a **meteor** in the celestial sphere as seen by the observer.

meteor shower. A number of **meteors** with approximately parallel trajectories.

meteor stream. A group of meteoric bodies with nearly identical **orbits.**

meteor trail = meteor train.

meteor train. Anything, such as light or ionization, left along the trajectory of the meteor after the head of the meteor has passed.

meteor wake. Meteor train phenomena of very short duration, in general much less than a second.

meter. 1. (*abbr* **m**) The basic unit of length of the **metric system,** defined as 1,650,763.73 wavelengths in vacuo of the unperturbed transition $2p_{10} - 5d_5$ in krypton^{86}.

Effective 1 July 1959 in the U.S. customary system of measures, 1 yard = 0.9144 meter, exactly, or 1 meter = 1.094 yards = 39.37 inches. The standard inch is exactly 25.4 millimeters.

2. A device for measuring, and usually indicating, some quantity.

metering jet. A **jet** in a **fuel-injection system.**

method of attributes. In reliability testing, measurement of quality by noting the presence or absence of some characteristic (attribute) in each of the units in the group under consideration and counting how many do or do not possess it.

An example of this method is go and no-go gaging of a dimension.

method of characteristics. See **characteristics.**

method of small perturbation = **perturbation method.**

Metonic cycle. A period of 19 years, after which the various **phases of the moon** fall on approximately the same days of the year as in the previous cycle.

The Metonic cycle is the basis for the golden numbers used to determine the date of Easter. Four such cycles form a Callippic cycle.

metric photography. The recording of events by means of photography (either singly or sequentially), together with appropriate **coordinates,** to form the basis for accurate measurements.

metric system. The international decimal system of weights and measures based on the **meter** and the **kilogram.**

The use of the metric system in the United States was legalized by Congress in 1866 but was not made obligatory.

metric wave. See **frequency bands.**

metrology. The science of dimensional measurement; sometimes includes the science of weighing.

Mev = ***million electron volt.***

Mic, Micr. International Astronomical Union abbreviations for *Microscopium.* See **constellation.**

Michaelson actinograph. A **pyrheliometer** of the bimetallic type used to measure the intensity of **direct solar radiation** in terms of the angular deflection of a blackened bimetallic strip exposed to the direct solar beams.

Micr. International Astronomical Union abbreviation for *Microscopium.* See **constellation.**

micro (*abbr*). **1.** (*abbr* μ). A prefix meaning divided by 10^6. **2.** A prefix meaning very small, as in micrometeorite.

microbar (*abbr* μ**b**). The unit of pressure in the **CGS system** and equal to 1 dyne per square centimeter; the unit of **sound pressure.**

In British literature the term *barye* has been used. The term *bar* properly denotes a pressure of 10^6 dynes per square centimeter. Unfortunately, the bar was once used in acoustics to mean 1 dyne per square centimeter, but this is no longer correct.

microenvironment. The **environment** created and maintained within a very small space, such as a pressurized capsule or space suit, and sufficient to support life in a reasonably normal manner.

microlock. A satellite **telemetry** system which uses **phase-lock** techniques in the ground receiving equipment to achieve extreme sensitivity.

micromanometer. A **manometer** capable of measuring very small pressure changes or differences.

micrometeorite. A very small **meteorite** or meteoritic particle with a diameter in general less than a millimeter.

micrometeorite penetration. Penetration of the thin outer shell (skin) of space vehicles by small particles travelling in space at high velocities.

micrometer. One of a class of instruments for making precise linear measurements in which the displacements measured correspond to the travel of a screw of accurately known **pitch.**

micron. (*abbr* μ). **1.** A unit of length equal to one-millionth of a meter or one-thousandth of a millimeter.

The micron is a convenient length unit for measuring wavelengths of infrared radiation, diameters of atmospheric particles, etc.

2. = **micron of mercury.**

micron liter. One liter of gas at a **pressure** of one **micron of mercury.**

micron of mercury (*abbr* μ **of Hg** or μ **Hg**). A unit of **pressure** equal to a pressure of 1/1000th of 1 millimeter of mercury pressure at °C and the standard acceleration of gravity; a millitorr (10^{-3} **torr** approximately). See **torr.**

microphone. An **electroacoustic transducer** which receives an **acoustic** signal and delivers a corresponding electric signal.

Microscopium (*abbr* **Mic, Micr**). See **constellation.**

microsecond (*abbr* μ**sec**). One-millionth of a second.

microtorr. A unit of *pressure* equal to 10^{-6} torr. See **torr.**

microwave. Of, or pertaining to, radiation in the **microwave region**

microwave refractometer. A device for measuring the **refractive index** of the atmosphere at microwave frequencies—usually in the 3-centimeter region.

microwave region. Commonly, that region of the radio spectrum between approximately 1000 megacycles and 300,000 megacycles. See **frequency band.**

Corresponding wavelengths are 30 centimeters to 1 millimeter.

The limits of the microwave region are not clearly defined but in general it is considered to be the region in which radar operates.

microwave turbulence. Irregular and fluctuating gradients of microwave **refractive index** in the atmosphere. See **optical turbulence.**

Microwave turbulence may be due either to blobby distribution of water vapor, or to thermal turbulence.

Midas. A two-object **trajectory measuring system** whereby two complete Cotar antenna systems and two sets of receivers at each station, with the multiplexing done after phase comparison, are utilized in tracking more than one object at a time.

midcourse guidance. **Guidance** of a **rocket** from the end of the launching phase to some arbitrary point or at some arbitrary time when **terminal guidance** begins. Also called *in-course guidance.* See **guidance.**

Midot (*abbr*) = ***m****ultiple* ***i****nterferometer* ***d****etermination* ***o****f* ***t****rajectories.*

Mie particle. See **Mie theory.**

Mie scattering. Any **scattering** produced by spherical particles without special regard to comparative size of radiation **wavelength** and particle diameter. See **Mie theory.**

Mie theory. A complete mathematical-physical theory of the **scattering** of **electromagnetic radiation** by spherical particles, developed by G. Mie in 1908. In contrast to **Rayleigh scattering,** the Mie theory embraces all possible ratios of diameter to wavelength.

The Mie theory is very important in meteorological optics, where diameter-to-wavelength ratios of the order of unity and larger are characteristic of many problems regarding haze and cloud scattering. Scattering of radar energy by raindrops constitutes another significant application of the Mie theory.

mil. **1.** One-thousandth of an inch. **2.** A unit of angular measurement, 1/6400 of a circle.

mile. A unit of distance. See **statute mile, nautical mile.**

military grid. Any **grid** specified for use on a particular map, or series of maps, by military authorities.

Milky Way. The **galaxy** to which the sun belongs.

As seen at night from the earth, the Milky Way is a faintly luminous belt of faint stars.

milli (*abbr* **m**). A prefix meaning multiplied by 10^{-3}.

millibar. A unit of pressure equal to 1000 dynes per square centimeter, or 1/1000 of a bar.

The millibar is used as a unit of measure of atmospheric pressure, a standard atmosphere being equal to 1,013.25 millibars or 29.92 inches of mercury.

milligal. A unit of **acceleration** equal to 1/1000 of a **gal,** or 1/1000 centimeter per second per second.

This unit is used in gravity measurements, being approximately one-millionth of the average gravity at the earth's surface.

millimeter (*abbr* **mm**). One-thousandth of a meter; one-tenth of a centimeter; 0.039370 U.S. inch.

millimeter of mercury (*abbr* **mm Hg**). A unit of **pressure** corresponding to a column of mercury exactly 1 millimeter high at 0° C under standard acceleration of gravity of 980.665 centimeters per second squared. See **torr.**

By *mercury at 0° C* is meant a hypothetical fluid having an invariable density exactly 13.5951 grams per cubic centimeter.

millimetric wave. See **frequency band.**

millimicron of mercury (*abbr* **mμ Hg**). A unit of **pressure** equal to 10^{-6} millimeters of mercury or 10^{-6} torr.

millimicrosecond (*abbr* **mμsec**) = **nanosecond.**

million electron volt (*abbr* **Mev**). A unit of energy equal to 1.603×10^{-8} ergs.

millisecond (*abbr* **msec**). One-thousandth of a second.

millitorr. A proposed new unit of pressure equal to 10^{-3} torr. See **torr.**

Mimas. A **satellite** of Saturn orbiting at a mean distance of 186,000 kilometers.

M-indicator = **M-display.**

mini. A contraction of *miniature* used in combination, as in *minicomponent, miniradio, minitransistor.*

miniature. Used attributively in reference to equipment, such as gimbals, gyroscopes, computers, etc., made small to fit into confined spaces, as within an earth satellite or rocket vehicle.

miniaturization. See **miniaturize.**

miniaturize. To construct a functioning miniature of a part or instrument. Said of telemetering instruments or parts used in an earth satellite or rocket vehicle, where space is at a premium. Hence, *miniaturized, miniaturization.*

minimum deviation. The least total **refraction** experienced by **radiation** passing through a prismatic refractive medium.

It is important to note that the refractive deviation is minimal, in general, only with respect to adjacent light paths, for there may exist a number of path directions through a single object, each one of which yields a local minimum deviation. When radiation has undergone minimum deviation, the angular difference in path directions before and after total refraction is termed the *angle of minimum deviation.*

minimum ionizing speed. The speed with which a **free electron** must move through a given gas to be able to **ionize** gas atoms or molecules by collision. In air at standard conditions, this speed is about 10^7 centimeters per second. See **electron avalanche.**

minitrack. A satellite tracking system consisting of a field of separate antennas and associated receiving equipment interconnected

so as to form interferometers which track a transmitting beacon in the payload itself.

minor axis. The shortest diameter of an **ellipse** or **ellipsoid.**

minor lobe. See **lobe.**

minor planet = **asteroid.** See **planet.**

minute (*abbr* **min** or **′**). **1.** The sixtieth part of an hour. **2.** The sixtieth part of a degree of arc.

mirage. A **refraction** phenomenon in the **atmosphere** wherein an image of some object is made to appear displaced from its true position. See **radio duct,** note.

Simple mirages may be any one of three types, the inferior mirage, the superior mirage, or the lateral mirage, depending, respectively, on whether the spurious image appears below, above, or to one side of the true position of the object. Of the three, the inferior mirage is the most common, being usually discernible over any heated street in daytime during summer. The abnormal refraction responsible for mirages is invariably associated with abnormal temperature distributions that yield abnormal spatial variations in the refractive index.

Miran (*abbr*) = ***missile ranging.***

Miranda. A **satellite** of Uranus orbiting at a mean distance of 124,000 kilometers.

mirror altitude. The altitude above the earth at which electrically charged **corpuscular** radiation impinging upon the earth is reflected by the **geomagnetic field.**

mirror ratio. See **magnetic mirror.**

mirror reflection = **specular reflection.**

missile. Any object thrown, dropped, fired, launched, or otherwise projected with the purpose of striking a target. Short for *ballistic missile, guided missile.*

Missile should not be used loosely as a synonym for *rocket* or *spacecraft.*

missile ranging (*abbr* **Miran**). A **trajectory measuring system** that measures **loop** ranges from a transmitter to a beacon to remote slave stations and back to the transmitter through comparison of time differences of **pulses.**

The transmitter interrogates at 600 megacycles and the beacon replies at 580 megacycles.

missilry. The art or science of designing, developing, building, launching, directing, and sometimes guiding a rocket **missile;** any phase or aspect of this art or science.

This term is sometimes spelled *missilery,* but is then pronounced as a three-syllable word.

mistake. An **error,** usually large, resulting from a human failing or an equipment malfunction.

mixed-base notation. A system of **positional notation** used in **computers** in which two or more **bases** are arranged according to a plan. See **biquinary notation.**

mixed-flow compressor. A rotary **compressor** through which the acceleration of fluid is partly radial and partly axial.

mixed reflection = **spread reflection.**

mixing length. A mean length of travel, characteristic of a particular motion in a fluid over which an **eddy** maintains its identity; analogous to the **mean free path** of a molecule.

Physically, the idea implies that mixing occurs by discontinuous steps, that fluctuations which arise as eddies with different characteristics wander about, and that the mixing is done almost entirely by the small eddies.

mixing ratio. In a system of moist air, the dimensionless ratio of the mass of **water vapor** to the mass of dry air. For many purposes, the mixing ratio may be approximated by the **specific humidity.** In terms of the pressure p and vapor pressure e, the mixing ratio w is

$$w = (0.622\, e)/(p - e)$$

Compare **absolute humidity, relative humidity, dew point.**

mixture ratio. In **liquid-propellant rockets,** the relative **mass flow rates** to the combustion chamber of **oxidizer** and **fuel.**

MKSA system. A system of units based on the **meter, kilogram, second,** and **ampere.** Also called **Giorgi system, international system.**

MKS system. A system of units based on the meter, the kilogram, and the second.

mobility. **1.** The average velocity or **drift velocity** that a charged particle in a **plasma** will acquire in response to a unit applied electric field when restrained by collisions with other particles. **2.** = **drift mobility.** **3.** = **Hall mobility.**

In general the electron mobility is considerably larger than any ion mobility.

mock test. An operational test of a complete **rocket** system without actually firing a rocket.

mockup. A full-sized replica or dummy of something, such as a spacecraft, often made of some substitute material such as wood, and sometimes incorporating actual functioning pieces of equipment, such as engines.

mode. A functioning position or arrangement that allows for the performance of a given task.

Said of a **spacecraft,** which may move, for example, from a *cruise mode* to an *encounter mode*; or said of controls that permit the selection of a mode, such as a *reentry mode.*

model atmosphere. **1.** Any theoretical representation of the **atmosphere,** particularly of vertical temperature distribution. See **adiabatic atmosphere, homogeneous atmosphere, isothermal atmosphere, thermotropic model, equivalent barotropic model,**

barotropic model. 2. = **standard atmosphere,** sense 1.

mode of vibration. In a system undergoing **vibration,** a characteristic pattern assumed by the system in which the motion of every particle is simple **harmonic** with the same **frequency.**

Two or more modes of vibration may exist concurrently in a multiple-degree-of-freedom system.

moderator. A material that has a high **cross section** for slowing down **fast neutrons** with a minimum of absorption, e.g., heavy water, beryllium, used in **reactor cores.**

Moderators are used to improve the neutron utilization by slowing the neutrons to low energies, thereby increasing the probability of fission capture in the nuclear fuel

mode shape = **mode of vibration.**

modified index of refraction. An atmospheric **index of refraction** mathematically modified so that when its gradient is applied to energy propagation over a hypothetical flat earth it is substantially equivalent to propagation over the true curved earth with the actual index of refraction. Also called *refractive modulus, modified refractive index.* Compare **potential index of refraction.**

The modified index of refraction is usually expressed in M–units; mathematically

$$M = \left(n - 1 + \frac{h}{a}\right)10^6 = N + \left(\frac{h}{a}\right)10^6$$

where n is the index of refraction at a point in the atmosphere; h is the height above mean sea level of that point; a is the radius of the earth; and N is the index of refraction in N-units.

In ray tracing problems, the vertical gradient dM/dh can be used directly to obtain a ray path curvature that is relative to the curvature of the earth, i.e.,

$$\frac{dM}{dh} = \frac{dN}{dh} + \frac{10^6}{a} = \frac{10^6}{ka}$$

where k is a value by which the earth's radius is multiplied to get the radius of curvature of the ray path; ka is called the *effective earth radius.*

modified refractive index = **modified index of refraction.**

modulated continuous wave (*abbr* **MCW**). A form of **emission** in which the **carrier** is modulated by a constant **audiofrequency** tone.

modulated wave. A **wave** which varies in some characteristic in accordance with the variations of a modulating **signal.** Compare **continuous wave.** See **modulation.**

modulating wave. See **modulation.**

modulation. 1. The variation in the value of some parameter characterizing a periodic **oscillation.** 2. Specifically, variation of some characteristic of a **radio wave,** called the *carrier wave,* in accordance with instantaneous values of another wave, called the *modulating wave.*

Variation of amplitude is *amplitude modulation,* variation of frequency is *frequency modulation,* and variation of phase is *phase modulation.* The formation of very short bursts of a carrier wave, separated by relatively long periods during which no carrier wave is transmitted, is *pulse modulation.*

modulation index = **ratio deviation.**

modulator. A device to effect the process of **modulation.**

module. 1. A self-contained unit of a **launch vehicle** or **spacecraft** which serves as a building block for the overall structure. The module is usually designated by its primary function as *command module, lunar landing module,* etc. 2. A one-package assembly of functionally associated electronic parts, usually a plug-in unit, so arranged as to function as a **system** or **subsystem;** a **black box.** 3. The size of some one part of a **rocket** or other structure, as the semidiameter of a rocket's base, taken as a unit of measure for the proportional design and construction of component parts.

modulus. (*plural* **moduli**) 1. A real, positive quantity which measures the **magnitude** of some number, as *the modulus of a complex number is the square root of the sum of squares of its components.* 2. A **coefficient** representing some elastic property of a body, such as the *modulus of elasticity* or the *modulus of resilience.*

modulus of elasticity (*symbol E*) = **Young modulus.**

Mögel-Dellinger effect = **fadeout.**

moist adiabatic lapse rate = **saturation adiabatic lapse rate.**

molar. Pertaining to a **mole,** or measured in moles.

moldavite. See **tektite.**

mole (*abbr* **mol**). The amount of substance containing the same number of atoms as 12 grams of pure carbon[12] (C^{12}).

The gram-mole or gram-molecule is the mass in grams numerically equal to the molecular weight.

molecular drag gage. A **vacuum gage** in which tangential **momentum** is transported (viscous transport) by gas molecules from a rapidly rotating member (usually in the form of a disk or cylinder) to a nearby movable member restrained by a restoring torque which can be correlated with gas pressure. Also called *molecular gage, rotating disk gage, rotating cylinder gage.*

molecular effusion. The passage of **gas** through a single opening in a plane wall of negligible thickness where the largest dimension of the hole is smaller than the **mean free path.**

molecular flow. The flow of gas through a duct

under conditions such that the **mean free path** is greater than the largest dimension of a transverse section of the duct.

molecular flux. The net number of gas molecules crossing a specified surface in unit time, those having a velocity component in the same direction as the normal to the surface at the point of crossing being counted as *positive* and those having a velocity component in the opposite direction being counted as *negative*.

molecular gage = molecular drag gage.

molecular scale temperature (*symbol* T_M). An atmospheric parameter defined by $T_M = (M_0/M)T$ where M_0 is the mean molecular weight at sea level, M is the mean molecular weight at altitude, and T is air temperature at altitude.

Up to an altitude of about 90 kilometers, the molecular composition of air is constant; thus, $M_0/M = 1$ and $T_M = T$. Above 90 kilometers, M_0/M is greater than unity, and T_M is greater than T.

molecular weight. The weight of a given **molecule** expressed in **atomic weight units.**

molecule. An aggregate of two or more **atoms** of a substance that exists as a unit.

Moll thermopile. A **thermopile** used in some types of radiation instruments. Alternate junctions of series-connected thermocouples are imbedded in a shielded nonconducting plate having a large heat capacity. The remaining junctions, which are blackened, are exposed directly to the radiation. The voltage developed by the thermopile is proportional to the intensity of radiation. See **solarimeter.**

moment (*symbol* M). A tendency to cause **rotation** about a point or axis, as of a control surface about its hinge or of an airplane about its center of gravity; the measure of this tendency, equal to the product of the force and the perpendicular distance between the point of axis of rotation and the line of action of the force.

moment of inertia (*symbol* I). Of a body about an axis, Σmr^2, where m is the mass of a particle of the body and r is its distance from the axis.

momentum. Quantity of motion.

Linear momentum is the quantity obtained by multiplying the mass of a body by its linear speed. Angular momentum is the quantity obtained by multiplying the moment of inertia of a body by its angular speed.

The momentum of a system of particles is given by the sum of the momentums of the individual particles which make up the system or by the product of the total mass of the system and the velocity of the center of gravity of the system.

The momentum of a continuous medium is given by the integral of the velocity over the mass of the medium or by the product of the total mass of the medium and the velocity of the center of gravity of the medium.

momentum thrust = thrust.

momentum-transport hypothesis. The hypothesis that **momentum** is conserved in turbulent **eddy** transfer.

This hypothesis is to be compared with the vorticity-transport hypothesis, the respective results being identical only if the eddy viscosity is constant.

Mon, Mono. International Astronomical Union abbreviations for *Monoceros.* See **constellation.**

monitor. To observe, listen in on, keep track of, or exercise surveillance over by any appropriate means, as, *to monitor radio signals; to monitor the flight of a rocket by radar; to monitor a landing approach.*

Monoceros (*abbr* **Mon, Mono**). See **constellation.**

monochromatic. Pertaining to a single **wavelength** or, more commonly, to a narrow band of wavelengths.

monocoque. A type of construction, as of a rocket body, in which all or most of the stresses are carried by the **skin.**

A monocoque may incorporate formers but not longitudinal members such as stringers.

monopropellant. A **rocket propellant** consisting of a single substance, especially a liquid, capable of producing a heated jet without the addition of a second substance.

Used attributively in phrases, such as *monopropellant rocket engine or motor, monopropellant rocket fuel, monopropellant system,* etc.

monostatic reflectivity. The characteristic of a reflector which reflects energy only along the line of the **incident** ray, e.g., a corner reflector. See **bistatic reflectivity.**

month. **1.** The period of the **revolution** of the moon around the earth.

The month is designated as *sidereal, tropical, anomalistic, draconitic,* or *synodical,* according to whether the revolution is relative to the stars, the vernal equinox, the perigee, the ascending node, or the sun.

2. The calendar month, which is a rough approximation to the **synodical month.**

month of the phases = synodical month.

moon. **1.** The natural satellite of the earth. **2.** A natural **satellite** of any planet. See **planet,** table.

moonrise. The crossing of the visible **horizon** by the **upper limb** of the ascending moon.

moonset. The crossing of the visible **horizon** by the **upper limb** of the descending moon.

MOPTAR (*abbr*) = ***m****ultiple* ***o****bject* ***p****hase* ***t****racking* ***a****nd* ***r****anging.*

motion. The act, process, or instance of change of position. Also called *movement,* especially when used in connection with problems involving the motion of one craft relative to another.

Absolute motion is motion relative to a fixed frame of reference. *Actual motion* is motion of a craft relative to the earth. *Apparent* or *relative motion* is change of position as observed from a reference point which may itself be in motion. *Diurnal motion* is the apparent daily motion of a celestial body. *Direct motion* is the apparent motion of a planet eastward among the stars; *retrograde motion*, the apparent motion westward among the stars. Motion of a celestial body through space is called *space motion*, which is composed of two components: *proper motion*, that component perpendicular to the line of sight; and *radial motion*, that component in the direction of the line of sight.

motion sickness. The syndrome of pallor, sweating, nausea, and vomiting which is induced by unusual **accelerations.**

motor. See **engine.**

motorboating. Oscillation in a system or component, usually manifested by a succession of **pulses** occurring at a **subaudio** or low-audio repetition **frequency.**

moving target indicator (*abbr* **MTI**). A device which limits the display of **radar** information primarily to moving **targets.**

M-region. See **M-region magnetic storm,** note.

M-region magnetic storm. A magnetic storm that is independent of visible solar disk features; it begins gradually and shows a strong tendency to recur within a period of 27 days.

The hypothetical region on the solar disk assumed to be the source of the incident corpuscular radiation is called the M-region.

M-scan = **M-display.**

M-scope = **M-display.**

MTI (*abbr*) = ***m**oving **t**arget **i**ndicator.*

MUF (*abbr*) = ***m**aximum **u**sable **f**requency.*

multi (*combining form*). More than one. Used in contexts where a category of two or more is distinguished from a category of one, as in *a multipropellent fuel system is more complicated than a monopropellant system.*

multicoupler. A device for connecting several **receivers** to one **antenna** and properly matching the impedances of the receivers and the antenna.

multipath = **multipath transmission.**

multipath transmission. The process, or condition, in which **radiation** travels between **source** and **receiver** via more than one path. Since there can be only one *direct* path, some process of **reflection, refraction,** or **scattering** must be involved. See **fading, Fresnel zone.** Also called *multipath.*

multiple airborne target trajectory system (*abbr* **Matts**). A long-baseline angle-measuring system consisting of two crossed-baseline angle-measuring-equipment (AME) stations. Each AME station simultaneously tracks three airborne targets by means of frequency sharing.

multiple-degree-of-freedom system. A mechanical **system** for which two or more **coordinates** are required to define completely the position of the system at any instant.

multiple interferometer determination of trajectories (*abbr* **Midot**). A **trajectory-measurement system** with multiple-object-tracking capability utilizing two or more short-baseline stations and a data output consisting of a series of amplitude nulls that represent **direction cosines** at given times in the flight.

multiple object phase tracking and ranging (*abbr* **Moptar**). A short-baseline continuous-wave phase comparison, **trajectory measuring system,** similar to the Cotar which consists of a crossed-baseline angle-measuring-equipment (AME) system and a distance-measuring-equipment (DME) system, wherein time sequencing of the ground station and **transponders** is used to track multiple targets.

multiple scattering. In contrast to primary scattering, any **scattering** in which radiation is scattered more than once before reaching the eye, antenna, or other sensing element.

multiple-stage compressor = **multistage compressor.**

multiple-stage rocket = **multistage rocket.**

multiple-unit steerable antenna. See **musa antenna.**

multiplexer. A mechanical or electrical device for time sharing of a **circuit.**

multiplexing. The simultaneous transmission of two or more **signals** within a single **channel.**

The three basic methods of multiplexing involve the separation of signals by time division, frequency division, and phase division.

multiplier. 1. A device which has two or more **inputs** and whose **output** is a representation of the product of the quantities represented by the input **signals. 2.** = **multiplier phototube.**

multiplier phototube. A **phototube** with one or more **dynodes** between its **photocathode** and the output **electrode.**

multipropellant. A **rocket propellant** consisting of two or more substances fed separately to the **combustion chamber.** See **bipropellant.**

multistage compressor. An **axial-flow compressor** having two or more, usually more than two, stages of rotor and stator blades; a radial-flow compressor having two or more **impeller wheels.** Also called a *multiple-stage compressor.*

multistage rocket. A vehicle having two or more **rocket** units, each unit firing after the

one in back of it has exhausted its **propellant.** Normally, each unit, or stage, is jettisoned after completing its firing. Also called a *multiple-stage rocket* or, infrequently, a *step rocket.*

multivibrator. A two-stage **regenerative circuit** with two possible states and an abrupt transition characteristic. See **bistable multivibrator.**

Multivibrators are used in digital computers for computation in **binary notation.**

M-unit. See **modified index of refraction.**

muon = mu meson. See **meson.**

Mus, Musc. International Astronomical Union abbreviations for *Musca.* See **constellation.**

musa antenna. A *m*ultiple-*u*nit *s*teerable *a*ntenna consisting of a number of stationary antennas, the composite major **lobe** of which can be aimed electrically.

Musca (*abbr* **Mus, Musc**). See **constellation.**

myria. A prefix meaning multiplied by 10^4.

myriameter = ten-thousand meters.

myriametric wave. See **frequency bands.**

N

NACA (*abbr*). ***N**ational **A**dvisory **C**ommittee for **A**eronautics.* The predecessor of NASA.

NACA Standard Atmosphere. See **standard atmosphere.**

nadir. That point on the **celestial sphere** vertically below the observer, or 180° from the **zenith.**

nano (*abbr* **n**). A prefix meaning multiplied by 10^{-9}.

nanosecond (*abbr* **nsec**). 10^{-9} second. Also called *millimicrosecond.*

Napierian base. The logarithmic base, *e.*

NASA (*abbr*). ***N**ational **A**eronautics and **S**pace **A**dministration.*

NASC (*abbr*). ***N**ational **A**eronautics and **S**pace **C**ouncil.*

natural coordinates. An **orthogonal,** or mutually perpendicular, system of **curvilinear coordinates** for the description of **fluid** motion, consisting of an axis T tangent to the instantaneous velocity vector and an axis N normal to this velocity vector to the left in the horizontal plane, to which a vertically directed axis Z may be added for the description of three-dimensional flow.

natural frequency. 1. The frequency of **free oscillation** of a system. For a multiple-degree-of-freedom system, the natural frequencies are the frequencies of the normal **modes** of vibration. **2.** The undamped **resonance frequency** of a physical system. It is expressed in cycles per unit time. The system may be mechanical, pneumatic, or electrical.

natural mode = normal mode of vibration.

natural year = tropical year.

nausea. A feeling of discomfort in the region of the stomach, with aversion to food and a tendency to vomit.

Nautical Almanac. An annual publication of the U.S. Naval Observatory and H.M. Nautical Almanac Office, Royal Greenwich Observatory, listing the Greenwich hour angle and declination of various **celestial bodies** to a precision of 0.1 minute of arc at hourly intervals; time of sunrise, sunset, moonrise, moonset; and other astronomical information useful to navigators. Prior to 1960 separate publications were issued by the two observatories entitled the *American Nautical Almanac* and the *Abridged Nautical Almanac.* See **American Ephemeris and Nautical Almanac.**

nautical mile. A unit of distance used principally in navigation. For practical navigation it is usually considered the length of 1 minute of any **great circle** of the earth, the **meridian** being the great circle most commonly used. Also called *sea mile.*

Because of various lengths of the nautical mile in use throughout the world, due to differences in definition and the assumed size and shape of the earth, the International Hydrographic Bureau in 1929 proposed a standard length of 1852 meters, which is known as the international nautical mile. This has been adopted by nearly all maritime nations. The U.S. Departments of Defense and Commerce adopted this value on July 1, 1954. With the yard-meter relationship then in use, the international nautical mile was equivalent to 6076.10333 feet. Using the yard-meter conversion factor effective July 1, 1959, the international nautical mile is equivalent to 6076.11549 international feet.

nautical twilight. That period when the **upper limb** of the sun is below the visible **horizon** and the center of the sun is not more than 12° below the celestial horizon.

nautical year = tropical year.

Navier-Stokes equations. The **equations of motion** for a **viscous fluid** which may be written

$$\frac{d\mathrm{N}}{dt} = -\frac{1}{\rho}\nabla p + F + \nu\nabla^2\mathrm{N} + \frac{1}{3}\nu\nabla(\nabla\cdot\mathrm{N})$$

where p is the pressure; ρ is the density; t is the time; F is the total external force; N is the fluid velocity; and ν is the kinematic viscosity. For an incompressible fluid, the term in $\nabla \cdot \mathrm{N}$ (divergence) vanishes and the effects of viscosity then play a role analogous to that of temperature in thermal conduction and to that of density in simple diffusion. See **viscosity, Ekman spiral.**

Solutions of the Navier-Stokes equations have been obtained only in a limited number of special cases. The equations are derived on the basis of certain simplifying assumptions concerning the stress tensor of the fluid; in one dimension they represent the assumption referred to as the Newtonian friction law.

navigation. The practice or art of directing the movement of a craft from one point to another.

Navigation usually implies the presence of a human, a navigator, aboard the craft. Compare **guidance.**

navigational planets. The four **planets** commonly used in celestial surface and air navigation: Venus, Mars, Jupiter, and Saturn.

navigational stars. The 57 stars included in the main listing of the *Nautical Almanac* and Polaris.

The navigational stars include almost all of the stars with common names. See table VII.

navigational triangle. The spherical triangle solved in computing **altitude** and **azimuth.** See **celestial triangle.**

The celestial triangle is formed on the celestial sphere by the great circles connecting the elevated pole, zenith of the assumed position of the observer, and a celestial body. The terrestrial triangle is formed on the earth by the great circles connecting the pole and two places on the earth. The term *astronomical triangle* applies to either the celestial or terrestrial triangle used for solving celestial observations.

navigation dome = astrodome.

N-display. In radar, a display similar to the **K-display** in which the **target** appears as a pair of vertical deflections or **blips** from the horizontal time base. Direction is indicated by the relative amplitude of the vertical deflections; target distance is determined by moving an adjustable signal along the baseline until it coincides with the horizontal position of the vertical deflections. The horizontal control is calibrated in distance. Also called *N-scan, N-scope, N-indicator.*

negative acceleration = deceleration.

negative altitude. See **altitude.**

negative divergence = convergence.

negative feedback. Feedback which results in decreasing the amplification.

negative g. In designating the direction of acceleration on a body, the opposite of *positive g*, for example, the effect of flying an outside loop in the upright seated position. See **physiological acceleration.**

negative temperature coefficient. 1. The partial derivative of any physical variable with respect to temperature, when the value of the variable decreases as temperature increases. **2.** The decrease in **reactivity** of a nuclear **reactor** with increase in temperature.

Increasing temperature within the reactor increases the average neutron energy. Since the cross section of the fissionable material decreases with increased neutron energy, the net effect of increased temperature is to decrease the number of fissions.

negaton. Variant spelling of *negatron.* See **electron.**

negatron. A negative electron. Sometimes shortened to *negaton.* See **electron.**

negentropy = average information content.

neper (*abbr* **n**). A measure of power equal to one-half the *Napierian logarithm* (logarithm to the base *e*) of the power ratio. 1 neper is equal to 8.686 **decibels.**

Under certain conditions the neper is a measure of the ratio of amplitudes of such physical quantities as voltage, current, particle velocities, and sound pressure.

The neper is not commonly used in English-speaking countries.

nephelometer. 1. General name for instruments which measure, at more than one angle, the **scattering** function of particles suspended in a medium. Information obtained from such instruments may be used to determine the size of the suspended particles and the visual range through the medium. **2.** An instrument for chemical analysis by measuring the light-scattering properties of a **suspension. 3.** =**nephometer.** See **visibility meter.**

nephelometry. 1. The study of **suspensoids** by means of light-scattering techniques. See **nephelometer. 2.** The study of the scattering properties of small samples of air and its suspensoids. **3.** Chemical analysis by use of the nephelometer.

nepheloscope. 1. An instrument for demonstrating the temperature changes which occur in air that is rapidly expanded or compressed. **2.** A laboratory instrument for the production of clouds by the condensation process. **3.** =**nephoscope.**

nephometer. A general term for instruments designed to measure the amount of cloudiness. An early type consists of a convex hemispherical mirror mapped into six parts. The amount of cloud coverage on the mirror is noted by the observer. Also called *nephelometer.* Compare **nephoscope.**

nephoscope. An instrument for determining the direction of cloud motion. There are two basic designs of nephoscope: the direct-vision nephoscope and the mirror nephoscope. Also called *nepheloscope.*

Neptune. See **planet,** table.

Nereid. A **satellite** of Neptune orbiting at a mean distance of 5,570,000 kilometers.

net radiation factor. The fraction of the total **energy** emitted by one surface or volume that is absorbed by another surface or volume directly and indirectly.

net thrust. The gross **thrust** of a jet engine minus the **drag** due to the **momentum** of the incoming air.

network. 1. A combination of **electrical elements. 2.** A group of parts or systems combined to provide a closed information loop, i.e., one that provides for inquiry or command, response, and interpretation of response in relation to inquiry or command.

neurology. The study of the anatomy, physiology, and pathology of the nervous system.

TABLE VII.—NAVIGATIONAL STARS
(for which the *Nautical Almanac* carries full navigational information)

Name	Bayer name	Origin of name	Meaning of name
Acamar	θ Eridani	Arabic	another form of Achernar
Achernar	α Eridani	Arabic	end of the river (Eridanus)
Acrux	α Crucis	Modern	coined from Bayer name
Adhara	ϵ Canis Majoris	Arabic	the virgin(s)
Aldebaran	α Tauri	Arabic	follower (of the Pleiades)
Alloth	ϵ Ursa Majoris	Arabic	another form of Capella
Alkaid	η Ursa Majoris	Arabic	leader of the daughters of the bier
Al Na'ir	α Gruis	Arabic	bright one (of the fish's tail)
Alnilam	ϵ Orionis	Arabic	string of pearls
Alphard	α Hydrae	Arabic	solitary star of the serpent
Alphecca	α Corona Borealis	Arabic	feeble one (in the crown)
Alpheratz	α Andromeda	Arabic	the horse's navel
Altair	α Aquilae	Arabic	flying eagle or vulture
Ankaa	α Phoenicis	Arabic	coined name
Antares	α Scorpii	Greek	rival of Mars (in color)
Arcturus	α Bootis	Greek	the bear's guard
Atria	α Trianguli Australis	Modern	coined from Bayer name
Avior	ϵ Carinae	Modern	coined name
Bellatrix	γ Orionis	Latin	female warrior
Betelgeuse	α Orionis	Arabic	the arm pit (of Orion)
Canopus	α Carinae	Greek	city of ancient Egypt
Capella	α Aurigae	Latin	little she-goat
Deneb	α Cygni	Arabic	tail of the hen
Denebola	β Leonis	Arabic	tail of the lion
Diphda	β Ceti	Arabic	the second frog (Fomalhaut was once the first)
Dubhe	α Ursa Majoris	Arabic	the bear's back
Elnath	β Tauri	Arabic	one butting with horns
Eltanin	γ Draconis	Arabic	head of the dragon
Enif	ϵ Pegasi	Arabic	nose of the horse
Fomalhaut	α Piscis Austrini	Arabic	mouth of the southern fish
Gacrux	γ Crucis	Modern	coined from Bayer name
Glenah	γ Corvi	Arabic	right wing of the raven
Hadar	β Centauri	Modern	leg of the centaur
Hamal	α Arietis	Arabic	full-grown lamb
Kaus Australis	ϵ Sagittarii	Ar., L.	southern part of the bow
Kochab	β Ursa Minoris	Arabic	shortened form of "north star" (named when it was that, c. 1500 BC–AD 300)
Markab	α Pegasi	Arabic	saddle (of Pegasus)
Menkar	α Ceti	Arabic	nose (of the whale)
Menkent	θ Centauri	Modern	shoulder of the centaur
Miaplacidus	β Carinae	Ar., L.	quiet or still waters
Mirfak	α Persei	Arabic	elbow of the Pleiades
Nunki	σ Sagittarii	Bab.	constellation of the holy city (Eridu)
Peacock	α Pavonis	Modern	coined from English name of constellation
Polaris	α Ursa Minoris	Latin	the pole (star)
Pollux	β Geminorum	Latin	Zeus' other twin son (Castor, α Geminorum, is first twin)
Procyon	α Canis Minoris	Greek	before the dog (rising before the dog star, Sirius)
Rasalhague	α Ophiuchi	Arabic	head of the serpent charmer
Regulus	α Leonis	Latin	the prince
Rigel	β Orionis	Arabic	foot (left foot of Orion)
Rigil Kentaurus	α Centauri	Arabic	foot of the centaur
Sabik	η Ophiuchi	Arabic	second winner or conqueror
Schedar	α Cassiopeiae	Arabic	the breast (of Cassiopeia)
Shaula	λ Scorpii	Arabic	cocked-up part of the scorpion's tail
Sirius	α Canis Majoris	Greek	the scorching one (popularly, the dog star)
Spica	α Virginis	Latin	the ear of corn
Suhail	λ Velorum	Arabic	shortened form of Al Suhail, one Arabic name for Canopus
Vega	α Lyrae	Arabic	the falling eagle or vulture
Zubenelgenubi	α Librae	Arabic	southern claw (of the scorpion)

[a] From H.O. Pub. No. 9, *American Practical Navigator*, U.S. Government Printing Office, 1958.

neuromuscular. Pertaining jointly to nerves and muscles, as *neuromuscular junction.*

neutral. Without an electrical charge; neither positive nor negative.

neutral line = Busch lemniscate.

neutral point. **1.** In atmospheric optics, one of several points in the sky for which the degree of **polarization** of **diffuse sky radiation** is zero.

In an ideal Rayleigh atmosphere there would be just two such points, the solar point and the antisolar point. Because of effects of multiple scattering and because of the action of scattering particles larger than molecules, the actual atmosphere is typically found to have quite different neutral points. In the vertical plane containing the observer's zenith and the sun, three neutral points are commonly found: the **Arago point,** the **Babinet point,** and the **Brewster point.**

2. In aircraft, that location of the center of gravity at which the aircraft would exhibit neutral aerodynamic **stability.** **3. = Lagrangian point.**

neutrino. A **subatomic particle** of zero, or near zero, rest mass, having no electric charge, postulated by Fermi (1934) in order to explain apparent contradictions to the law of conservation of energy in beta-particle emission.

According to Fermi theory, the atomic nucleus in beta decay releases energy partly in the form of electrons (beta particles) and partly in the form of neutrinos.

neutron. A **subatomic particle** with no electric charge, and with a mass of 1.67482×10^{-24} gram.

Protons and neutrons comprise atomic nuclei; and they are both classed as *nucleons.*

neutron flux. The sum of the distances traveled by all the **neutrons** in 1 cubic centimeter in 1 second. Normally the figure must be energy qualified, e.g., thermal, intermediate, or fast neutron flux.

neutrosphere. The **atmospheric shell** from the earth's surface upward in which the atmospheric constituents are for the most part not ionized, i.e., it is electrically neutral.

The region of transition between the neutrosphere and the ionosphere is somewhere between 70 and 90 kilometers, depending on latitude and season.

Newcomb tables of the sun. See **ephemeris time.**

new moon. The moon at **conjunction,** when little or none of it is visible to an observer on the earth because the illuminated side is away from him. Also called *change of the moon.* See **phases of the moon.**

newton. The unit of force in the **MKSA system;** that force which gives to a mass of 1 kilogram an acceleration of 1 meter per second squared.

Newton equations of motion = Newton laws of motion.

Newton formula for the stress = Newtonian friction law.

Newtonian friction law. The statement that the tangential force (i.e., the force in the direction of the **flow**) per unit area acting at an arbitrary level within a **fluid** contained between two rigid horizontal plates, one of which is motionless and the other of which is in steady motion, is proportional to the shear of the fluid motion at that level. Mathematically, the law is given by

$$\tau = \mu\ (\partial u/\partial z)$$

where τ is the tangential force per unit area, usually called the shearing stress; μ is a constant of proportionality called the dynamic viscosity; and $\partial u/\partial z$ is the shear of the fluid flow normal to the resting plate. Also called *Newton formula for the stress.*

Newtonian mechanics. The system of mechanics based upon **Newton laws of motion** in which **mass** and **energy** are considered as separate, conservative, mechanical properties, in constrast to their treatment in relativistic mechanics.

Newtonian speed of sound. An approximation to the speed of sound a in a **perfect gas** given by the relation

$$a^2 = p/\rho$$

where p is pressure and ρ is density. Compare **Laplacian speed of sound.** See **acoustic velocity.**

Newton derived this expression by assuming the propagation of sound to be an isothermal process. It leads to values about 16 percent below those observed.

Newtonian telescope. A **reflecting telescope** in which a small plane mirror reflects the convergent beam from the objective to an eyepiece at one side of the telescope. After the second reflection the rays travel approximately perpendicular to the longitudinal axis of the telescope. See **Cassegrain telescope.**

Newtonian universal constant of gravitation = gravitional constant.

Newton law of cooling. See **thermal conductivity.**

Newton law of gravitation. Every particle of matter in the universe attracts every other particle with a force, F, acting along the line joining the two particles, proportional to the product of the masses m_1m_2 of the particles and inversely proportional to the square of the distance r between the particles, or

$F = Gm_1m_2/r^2$, where G = gravitational constant.

Newton laws of motion. A set of three fundamental postulates forming the basis of the mechanics of rigid bodies, formulated by Newton in 1687.

The first law is concerned with the principle of inertia and states that if a body in motion is not acted upon by an external force, its momentum remains constant (law of conservation of momentum). The second law asserts that the rate of change of momentum of a body is proportional to the force acting upon the body and is in the direction of the applied force. A familiar statement of this is the equation

$$F = ma$$

where F is vector sum of the applied forces, m is the mass, and a is the vector acceleration of the body. The third law is the principle of action and reaction, stating that for every force acting upon a body there exists a corresponding force of the same magnitude exerted by the body in the opposite direction.

N-indicator = N-display.

nitrogen cycle. The exchange of nitrogen between animals and plants, in which plants convert urea or nitrates to protein, animals digest protein and excrete its nitrogen content as urea, which is taken up again by plants.

nitrogen desaturation. The reduction of the nitrogen content of the tissues of the body by breathing gases not containing nitrogen.

noctilucent clouds. Clouds of unknown composition which occur at great heights, 75 to 90 kilometers. They resemble thin cirrus, but usually with a bluish or silverish color, although sometimes orange to red, standing out against a dark night sky. Sometimes called *luminous clouds.*

These clouds have been seen rarely, and then only during twilight, especially with the sun between 5° and 13° below the horizon; they have been observed only during summer months in both hemispheres (between latitudes 50° to 75° N and 40° to 60° S), and only in some parts of these latitude belts.

nocturnal radiation = effective terrestrial radiation.

nodal point = node.

node. 1. One of the two points of intersection of the **orbit** of a planet, planetoid, or comet with the **ecliptic,** or of the orbit of a **satellite** with the plane of the orbit of its **primary.** Also called *nodal point.* See **regression of the nodes.**

That point at which the body crosses to the north side of the reference plane is called the *ascending node*; the other, the *descending node.* The line connecting the nodes is called *line of nodes.*

2. A point, line, or surface in a **standing wave** where some characteristic of the wave field has essentially zero amplitude.

The appropriate modifier should be used before the word *node* to signify the type that is intended; e.g., *displacement node, velocity node, pressure node.*

3. A terminal of any branch of a *network* or a terminal common to two or more branches of a network. Also called *junction point, branch point,* or *vertex.*

nodical month = dracontic month.

nodical period. The interval between successive passages of a **satellite** through the **ascending node.**

noise. 1. Any undesired **sound.** By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device.

When caused by natural electrical discharges in the atmosphere, noise may be called *static.*

2. An erratic, intermittent, or statistically random **oscillation.** 3. In electrical circuit analysis, that portion of the unwanted **signal** which is statistically random, as distinguished from hum, which is an unwanted signal occurring at multiples of the power-supply frequency.

If ambiguity exists as to the nature of the noise, a phrase such as *acoustic noise* or *electric noise* should be used.

Since the above definitions are not mutually exclusive, it is usually necessary to depend on context for the distinction. See **white noise.**

noise level. See **level.**

nonadiabatic process. See **diabatic process.**

noncoherent echo. See **coherent echo.**

noncondensable gas. A gas whose temperature is above its **critical temperature,** so that it cannot be liquefied by increase of pressure alone.

nondimensional number. A pure number not involving any physical dimensions, e.g., a ratio of two velocities or two lengths.

Such numbers are fundamental descriptive quantities of a physical system. Nondimensional numbers involving several variables often are interpreted as estimates of characteristic velocity ratios, force ratios, heat transfer ratios, frequency ratios, etc. Usually several different ratio interpretations are possible and useful for the same number. (See **Mach number, Reynolds number, Boussinesq number, Cauchy number, Prandtl number, Péclet number, Rayleigh number, Strouhal number, Richardson number, Nusselt number, Grashof number, Taylor number, Froude number.**)

nondimensional parameter. Any parameter of a problem which has the dimensions of a pure number, usually rendered so deliberately. See **nondimensional number.**

nonimpinging injector. An **injector** used in rocket engines which employs parallel streams of propellant usually emerging normal to the face of the injector.

In this injector, mixing is usually obtained by turbulence and diffusion. The V–2 used a nonimpinging injector.

nonlinear damping. Damping due to a damping **force** that is not proportional to **velocity.**

The words *force* and *velocity* should be treated in the

generalized sense. For example, they can be replaced by *voltage* and *current*, respectively.

nonlinear distortion. **Distortion** caused by a deviation from a proportional relationship between specified measures of the output and input of a system.

The related measures need not be output and input values of the same quantity; e.g., in a linear detector, the desired relation is between the output signal voltage and the input modulation envelope.

nonvolatile. Of a **computer** or computer component. The ability to retain information in the absence of power as *nonvolatile memory, nonvolatile storage.*

nonvolatile storage = permanent memory.

noon. The instant at which a time reference is over the **upper branch** of the **reference meridian.**

Noon may be *solar* or *sidereal* as either the sun or vernal equinox is over the upper branch of the reference meridian. Solar noon may be further classified as *mean* or *apparent* as the mean or apparent sun is the reference. Noon may also be classified according to the reference meridian, either the local or Greenwich meridian or additionally in the case of mean noon, a designated time zone meridian.

Nor, Norm. International Astronomical Union abbreviations for Norma. See **constellation.**

Norma (*abbr* **Nor, Norm**). See **constellation.**

normal. **1.** Equivalent to usual, regular, rational, or standard conditions. **2.** Perpendicular.

A line is normal to another line or a plane when it is perpendicular to it. A line is normal to a curve or curved surface when it is perpendicular to the tangent line or plane at the point of tangency.

3. Referring to thermal radiation properties, in a direction perpendicular to the surface. **4.** The line **normal,** sense **2,** to a surface.

normal dispersion. **Dispersion** of an **electromagnetic wave** characterized by an increase in **refractive index** with increase in frequency.

normal distribution. The fundamental frequency distribution of statistical analysis. A continuous variate x is said to have a normal distribution or to be normally distributed if it possesses a density function $f(x)$ which satisfies the equation

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}$$

where μ is the arithmetic mean (or first moment) and σ is the standard deviation. Also called *Gaussian distribution.*

About two-thirds of the total area under the curve is included between $x = \mu - \sigma$ and $x = \mu + \sigma$. The corresponding frequency distribution of vectors is the normal circular distribution in which the frequencies of vector deviations are represented by a series of circles centered on a vector mean. When applied to error distribution, this function is the *normal law of errors,* and the distribution is called the *normal curve of error.*

normal emittance. **Emittance** in a direction perpendicular to the surface or in a small solid angle whose axial ray is perpendicular to the surface.

normal functions. See **orthogonal functions.**

normal gravity. See **acceleration of gravity.**

normalize. **1.** To change in scale so that the sum of squares, or the integral of the squares of the transformed quantity is unity. See **orthogonal functions.** **2.** To transform a random variable so that the resulting random variable has a normal distribution. **3.** In computer operations, to adjust the exponent and coefficient of a **floating-point** result so that the coefficient is in the prescribed normal range. Also called *standardize.*

normal mode of vibration. A **mode of free vibration** of an undamped system. In general, any composite motion of a vibrating system can be analyzed into a summation of its normal modes. Also called *natural mode, characteristic mode,* and *eigenmode.*

normal plane. In aerodynamics, a plane at right angles to the **longitudinal axis** of an **aerodynamic vehicle.**

normal shock = normal shock wave.

normal shock wave. A **shock wave** perpendicular, or substantially so, to the direction of flow in a **supersonic flow** field. Sometimes shortened to *normal shock.*

northbound node = ascending node.

northern lights = aurora borealis.

north polar sequence. A list of stars near the north celestial pole arranged in order of photographic **magnitude,** used as reference stars in stellar **photometry.**

north pole. **1.** In astronomy, that end of the axis of rotation of a celestial body at which, when viewed from above, the body appears to rotate in a clockwise direction. See **celestial pole, ecliptic pole, geographical pole, geomagnetic pole, magnetic pole.** **2.** The north-seeking end of a magnet.

north-upward plan position indicator. See **plan position indicator.**

nose cone. The cone-shaped leading end of a **rocket vehicle,** consisting (a) of a chamber or chambers in which a satellite, instruments, animals, plants, or auxiliary equipment may be carried, and (b) of an outer surface built to withstand high temperatures generated by **aerodynamic heating.**

In a satellite vehicle, the nose cone may become the satellite itself after separating from the final stage of the rocket or it may be used to shield the satellite until orbital speed is accomplished, then separating from the satellite.

nose gear. That part of a **landing gear** which is located at the forward end of the vehicle.

notation. A manner of representing quantities. See **positional notation, binary notation, biquinary notation, decimal notation, fixed point, floating point, hexidecimal notation, octal notation, | sexidecimal notation, ternary notation.**

NOT circuit. In computers, a device or **circuit** which inverts the **polarity** of a **pulse.** Also called *inverter.*

nova (*plural* **novae**). A star which suddenly becomes many times brighter than previously, and then gradually fades.

nozzle (*symbol* n used as subscript). **1.** A duct, tube, pipe, spout, or the like through which a **fluid** is directed and from the open end of which the fluid is discharged, designed to meter the fluid or to produce a desired direction, velocity, or shape of discharge. See **de Laval nozzle, jet nozzle, supersonic nozzle. 2.** Specifically, that part of a **rocket thrust chamber** assembly in which the gases produced in the chamber are accelerated to high velocities.

nozzle blade. Any one of the blades or vanes in a **nozzle diaphragm.** Also called a *nozzle vane.*

nozzle-contraction area ratio (*symbol* ϵ_c). Ratio of the cross-sectional area for gas flow at the nozzle inlet to that at the throat.

nozzle diaphragm. A ring of stationary, equally spaced blades or vanes, forming an annulus of nozzles through which fluid is directed onto a turbine wheel. Sometimes called a *nozzle ring.*

nozzle-divergence loss factor (*symbol* λ). The ratio between the momentum of the gases in a nozzle with an angle $2a$ and the momentum of an **ideal nozzle.** In mathematical form

$$\lambda = \tfrac{1}{2}(1 + \cos a)$$

nozzle efficiency. The efficiency with which a **nozzle** converts **potential energy** into **kinetic energy,** commonly expressed as the ratio of the actual change in kinetic energy to the ideal change at the given pressure ratio.

nozzle exit area. The cross-sectional area of a rocket **nozzle** available for gas flow measured at the nozzle exit.

nozzle-expansion area ratio. (*symbol* ϵ_e). Ratio of the cross-sectional area for gas flow at the exit of a **nozzle** to the cross-sectional area available for gas flow at the throat.

nozzle ring = nozzle diaphragm.

nozzle throat. The portion of a **nozzle** with the smallest cross section.

nozzle throat area. The area of the minimum cross section of a rocket **nozzle.**

nozzle thrust coefficient (*symbol* C_F). A measure of the amplification of **thrust** due to gas expansion in a particular nozzle as compared with the thrust that would be exerted if the **chamber pressure** acted only over the **throat** area. Also called *thrust coefficient.*

nozzle vane = nozzle blade.

N-scan = N-display.

N-scope = N-display.

nuclear Bohr magneton = nuclear magneton.

nuclear cross section (*symbol* σ). A measure of the probability that the reaction will take place which is defined by

$$dI = In\,\sigma\,dx$$

where I is the intensity of the particle beam; n is the number of target nuclei per cubic centimeter of target; σ is the cross section for the specified process, expressed in square centimeters; and x is the target thickness in centimeters. See **barn.**

nuclear-electric rocket engine. A rocket engine in which a **nuclear reactor** is used to generate electricity which is used in an electric propulsion system or as a heat source for the working fluid.

nuclear emulsion. A very thick photographic emulsion used in the study of **cosmic rays** and other energetic particles. The path of the particle through the thick emulsion is recorded in three dimensions.

nuclear fuel. Fissionable material of reasonable long life, used or usable in producing energy in a **nuclear reactor.**

nuclear magneton (*symbol* M_N). A unit of magnetic moment of the proton equal to 5.0505×10^{-24} erg per gauss.

nuclear radiation. Corpuscular emissions, such as **alpha** and **beta particles,** or **electromagnetic radiation,** such as **gamma rays,** originating in the nucleus of an atom.

nuclear reactor. An apparatus in which nuclear **fission** may be sustained in a self-supporting **chain reaction.** Commonly called *reactor.* Formerly called *pile.*

nuclear rocket engine. A rocket engine in which a **nuclear reactor** is used as a power source or as a source of thermal energy.

nucleon. In the classification of **subatomic particles** according to mass, the second heaviest type of particle; its mass is intermediate between that of the **meson** and the **hyperon.**

Examples of the nucleon are the proton and neutron.

nucleus. **1.** The positively charged core of an **atom** with which is associated practically the whole mass of the atom but only a minute part of its volume.

A nucleus is composed of one or more protons and an approximately equal number of neutrons. The atomic number Z of the element indicates the number of protons in the nucleus. The mass number A of the element is the sum of the protons and neutrons.

2. In biology, a definitely delineated body within a cell containing the chromosomes.

nuclide. An individual **atom** of given **atomic number** Z and **mass number** A, for example, $_{92}U^{235}$.

A nuclide is any species of atom that exists for a measurable length of time and has a nuclear structure distinct from that of any other species of atom.

null. In direction-finding systems wherein the output amplitude is a function of the direction of arrival of the signal, the minimum output amplitude (ideally zero).

The null is frequently employed as a means of determining bearing. The term *minimum* is often used to indicate an imperfect null.

number. In computer operations, **(a)** amount of units by count, **(b)** a magnitude or quantity represented by group of **digits.**

The term *quantity* is preferred to *number* in sense **(b).**

number system. A scheme for representing magnitudes or quantities by a group of **digits.** See **numeric coding, positional notation.**

numeric. Composed wholly or partly of **digits.** See **alphanumeric, number.**

numerical aperture. The quantity $n \sin \theta$, the product of the **index of refraction** of the object medium, usually air, multiplied by the sine of the slope angle of the outermost ray from an axial point on the object.

numeric coding. A system of coding in which information is represented by **digits.** See **alphabetic coding, alphanumeric.**

N-unit. A unit of **index of refraction** in the atmosphere; a mathematical simplification designed to replace rather awkward numbers involved in the values of the index of refraction n for the atmosphere. It is defined by the relation

$$N = (n - 1)10^6$$

Thus, if $n = 1.000326$, then $N = 326$. Correspondingly, M-units are used for modified index of refraction, and B-units for potential index of refraction.

Nusselt number (*symbol* N_{Nu}). (After Wilhelm Nusselt, 1882– , German engineer.) A number expressing the ratio of convective to conductive **heat transfer** between a solid boundary and a moving fluid, defined as hl/k where h is the heat-transfer coefficient, l is the characteristic length, and k is the thermal conductivity of the fluid.

nutating feed. In a **tracking radar** an oscillating antenna **feed** for producing an oscillating deflection of the **beam** in which the plane of **polarization** remains fixed.

nutation. **1.** The **oscillation** of the axis of any rotating body, as a gyroscope rotor. **2.** Specifically, in astronomy, irregularities in the precessional motion of the **equinoxes** because of varying positions of the moon and, to a lesser extent, of other celestial bodies with respect to the **ecliptic.**

Because of nutation, the earth's axis nods like a top, describing a slightly wavy circle about the ecliptic pole. The maximum displacement is about 9.21 seconds (constant of nutation) and the period of a complete cycle is 18.60 tropical years (period of moon's node, nutation period).

nutation period. See **nutation,** note.

nutator. A mechanical device for gyrating the antenna **feed** horn or dipole of a **radar** about the axis of the reflector without changing its **polarization.**

Nyquist frequency. The highest frequency which can be determined in a **Fourier analysis** of a discrete sampling of data. If a time series is sampled at interval Δt, this frequency is $1/2\Delta t$ cycles per second. Also called *turnover frequency.*

nystagmus. An involuntary oscillation of the eyeballs, especially occurring as a result of eye fixations and stimulations of the inner ear during rotation of the body.

O

Oberon. A **satellite** of Uranus orbiting at a mean distance of 587,000 kilometers.

object glass = objective.

objective. The lens or combination of lenses which receives light rays from an object and refracts them to form an image in the focal plane of the eyepiece of an optical instrument, such as a telescope. Also called *object glass.*

oblate spheroid. An **ellipsoid** of **revolution,** the shorter **axis** of which is the axis of revolution.

An ellipsoid of revolution, the longer axis of which is the axis of revolution, is called a *prolate spheroid.* The earth is approximately an oblate spheroid.

oblique. Pertaining to, or measured on, an oblique projection, as *oblique equator, oblique pole, oblique latitude.*

oblique coordinates. Magnitudes defining a point relative to two intersecting nonperpendicular lines, called *axes.* See **Cartesian coordinates.**

The magnitudes indicate the distance from each axis, measured along a parallel to the other axis. The horizontal distance is called the *abscissa* and the other distance, the *ordinate.*

oblique projection. A map **projection** with an **axis** inclined at an oblique angle to the plane of the **equator.**

oblique shock = oblique shock wave.

oblique shock wave. A **shock wave** inclined at an oblique angle to the direction of flow in a **supersonic flow** field. Sometimes shortened to *oblique shock.* Compare **normal shock.**

obliquity of the ecliptic (*symbol* ϵ). The angle between the plane of the **ecliptic** (the plane of the earth's orbit) and the plane of the **celestial equator.**

The obliquity of the ecliptic is computed from the following formula: 23 degrees 27 minutes 08.26 seconds $-$ $0.4684(t - 1900)$ seconds, where t is the year for which the obliquity is desired.

observed. In astronomy and navigation, pertaining to a value which has been measured in contrast to one which is computed.

observed altitude = true altitude.

occlusion. Specifically, the trapping of undissolved **gas** in a solid during solidification.

occultation. The disappearance of a body behind another body of larger apparent size.

When the moon passes between the observer and a star, the star is said to be *occulted.* The three associated terms, *occultation, eclipse,* and *transit,* are exemplified by the motions of the satellites of Jupiter. An eclipse occurs when a satellite passes into the shadow cast by the planet; an occultation occurs when a satellite passes directly behind the planet, so that it could not be seen even if it were illuminated; and a transit occurs when a satellite passes between the observer and the planet, showing against the disk of the planet.

Oct, Octn. International Astronomical Union abbreviations for *Octans.* See **constellation.**

octal notation. Notation of numbers in the scale of eight. The octal digits can be represented by the eight possible combinations of three **binary digits.**

octant. See **sextant.**

octave. The interval between any two **frequencies** having the ratio of 1:2.

The interval in octaves between any two frequencies is the logarithm to the base 2 (or 3.322 times the logarithm to the base 10) of the frequency ratio.

Octn. International Astronomical Union abbreviation for *Octans.* See **constellation.**

ocular. Pertaining to or in relation with the eye.

oculogravic illusion = agravic illusion.

oculogyral illusion. The apparent movement of an image in space in the same direction as that in which one seems to be turning when the **semicircular canals** are stimulated.

oculogyric. Referring to movements of the eyes.

oersted. The **centimeter-gram-second** electromagnetic unit of **magnetic intensity.** See **gauss.**

off-center plan position indicator. See **plan position indicator.**

ogive. A body of revolution formed by rotating a circular arc about an axis that intersects the arc; the shape of this body; also, a nose of a projectile or the like so shaped.

Typically, an ogive has the outline of a Gothic arch, although by definition it may be rounded rather than pointed. See **tangent ogive.**

ohm (*abbr* Ω). The unit of electrical resistance; the resistance between two points of a conductor when a constant difference of potential of 1 **volt,** applied between these two points, produces in the conductor a current of 1 **ampere** (the conductor not being the source of any electromotive force).

ohmic heating. In **plasma physics,** the **energy** imparted to charged particles as they

respond to an electric field and make collisions with other particles.

The name was chosen for its similarity to the heat generated in an ohmic resistance due to the collisions of the charge carriers in their medium.

oilcan. Of a sheet-metal skin or of other covering, to snap in and out between rows of rivets or between other places of support in a fashion like that of the bottom of an oilcan.

omni. **1.** A prefix meaning *all*, as in *omnidirectional*. **2.** Short for *omnirange*.

omnidirectional range = omnirange.

omnirange. A radio navigation system providing a direct indication of the **bearing** of the omnirange facility from the vehicle. Usually used in combination with **distance-measuring equipment.** Also called *omnidirectional range*.

opacity. Of an optical path, the reciprocal of **transmission.** See **transmittance.**

opaque plasma. A **plasma** through which an **electromagnetic wave** cannot propagate and is either absorbed or reflected.

In general, a plasma is opaque for frequencies below the plasma frequency. The fact that a plasma is opaque over a certain frequency range will change the radiation properties within that frequency range. Any radiation emitted within the volume of the plasma is quickly absorbed. In this opaque region, therefore, the plasma can only radiate from its surface.

open-center plan position indicator. See **plan position indicator.**

open loop. A **system** operating without **feedback,** or with only partial feedback. See **closed loop.**

open system. A system that provides for the body's metabolism in an aircraft or spacecraft cabin by removal of respiratory products and of waste from the cabin and by use of stored food and oxygen. Compare **closed system.**

operand. In **computer** operations, a word on which an operation is to be performed.

operating ratio = computing efficiency.

operative temperature. In the study of human bioclimatology, one of several parameters devised to measure the air's cooling effect upon a human body. It is equal to the temperature at which a specified hypothetical environment would support the same heat loss from an unclothed, reclining human body as the actual environment. In the hypothetical environment, the wall and air temperatures are equal and the air movement is 7.6 centimeters per second. From experiment it has been found that the operative temperature

$$T_o = 0.48t_r + 0.19[\sqrt{vt_a} - (\sqrt{v} - 2.76)t_s]$$

where t_r is the mean radiant temperature; t_a is the mean air temperature; t_s is the mean skin temperature (all in °C); and v is the airspeed in centimeters per second.

Oph, Ophi. International Astronomical Union abbreviations for *Ophiuchus*. See **constellation.**

Ophiuchus (*abbr* **Oph, Ophi**). See **constellation.**

opposition. **1.** The situation of two **celestial bodies** having either **celestial longitudes** or **sidereal hour angles** differing by 180°. The term is usually used only in relation to the position of a planet or the moon from the sun. Compare **conjunction.** **2.** The situation of two **periodic** quantities differing by half a **cycle.**

optical air mass (*symbol* m). A measure of the length of the path through the atmosphere to sea level traversed by light rays from a celestial body, expressed as a multiple of the path length for a light source at the **zenith.** Originally called, simply, *air mass*. Also called *airpath*.

optical axis. Of an antenna, a line parallel to, but offset from, the electrical axis of an **antenna.**

This axis is offset by the distance necessary to have the optical sighting device removed from the electrical center of the antenna.

optical density = photographic transmission density.

optical depth = optical thickness.

optical double star. Two stars in nearly the same line of sight but differing greatly in distance from the observer, as distinguished from a **physical double star.**

optical haze = terrestrial scintillation.

optical line of sight. The generally curved path of visible light through the atmosphere.

Often used erroneously for *geometrical line of sight*.

optically effective atmosphere. That portion of the **atmosphere** lying below the altitude from which scattered light at twilight still reaches the observer with sufficient intensity to be discerned. Also called *effective atmosphere*.

The top of this region lies between 50 and 60 kilometers.

optical maser = laser.

optical path. **1.** = **line of sight.** **2.** The path followed by a ray of light through an optical system.

optical pyrometer. A device for measuring the **temperature** of an incandescent radiating body by comparing its **brightness** for a selected wavelength interval within the **visible spec-**

trum with that of a standard source; a monochromatic radiation **pyrometer.**

Temperatures measured by optical pyrometers are known as *brightness temperatures* and except for black bodies are less than the true temperatures.

optical slant range. The horizontal distance in a **homogeneous atmosphere** for which the **attenuation** is the same as that actually encountered along the true oblique path.

optical thickness. Specifically, in calculations of the transfer of **radiant energy,** the mass of a given absorbing or emitting material lying in a vertical column of unit cross-sectional area and extending between two specific levels. Also called *optical depth.*

If z_1 and z_2 are the lower and upper limits, respectively, of a layer in which the variation of a density ρ of some absorbing or emitting substance is given as a function of height z, then the quantity

$$\int_{z_1}^{z_2} \rho(z)\, dz$$

is called the optical thickness of that substance within that particular layer.

optical turbulence. Irregular and fluctuating gradients of optical **refractive index** in the atmosphere.

Optical turbulence is caused mainly by mixing of air of different temperatures, and particularly by thermal gradients which are sufficient to reverse the normal decrease in density with altitude, so that convection occurs.

optics. See **atmospheric optics.**

optimal. Pertaining to a **trajectory,** path, or control motion, one that minimizes or maximizes some quantity or combination of quantities such as fuel, time, energy, distance, heat transfer, etc. This optimum condition, or path, is commonly calculated by a type of mathematics known as *calculus of variations.*

OR. **1.** The **logical operator** which has the property that A or B is true if either A is true or B is true. **2.** In **Boolean algebra,** the operation of **union.**

orbit. **1.** The path of a body or particle under the influence of a **gravitational** or other force. For instance, the orbit of a **celestial body** is its path relative to another body around which it revolves.

Orbit is commonly used to designate a closed path and *trajectory* to denote a path which is not closed. Thus, *the trajectory of a sounding rocket, the orbit of a satellite.*

2. To go around the earth or other body in an orbit, sense **1.**

orbital. Taking place in orbit, as *orbital refueling, orbital launch,* or pertaining to an orbit as *orbital plane.*

orbital elements. A set of seven parameters defining the **orbit** of a body attracted by a central, inverse-square force.

Several different sets of parameters have been used. For artificial satellites the elements usually given are: longitude of the ascending node, Ω; inclination of the orbit plane, i; argument of perigee, ω; eccentricity, e; semimajor axis, a; mean anomaly, M; and epoch, t_o.

orbital glider. See **hypersonic glider.**

orbital motion. Continuous motion in a closed path such as a circle or an ellipse.

orbital period. The interval between successive passages of a **satellite** through the same point in its **orbit.** Often called *period.* See **anomalistic period, nodical period, sidereal period.**

orbital velocity. **1.** The average velocity at which an earth **satellite** or other orbiting body travels around its **primary.** Compare **separation velocity.** **2.** The velocity of such a body at any given point in its orbit, as in *its orbital velocity at the apogee is less than at the perigee.* **3.** = **circular velocity.**

orbiting. Of a **spacecraft,** in orbit about the earth or other spatial body, as in *an orbiting astronomical laboratory.*

OR-circuit = **OR-gate.**

order of magnitude. A factor of 10. Compare **octave, magnitude.**

Two quantities of the same kind which differ by less than a factor of 10 are said to be of the same *order of magnitude.*

Order of magnitude is used loosely by many writers to mean a pronounced difference in quantity but the difference may be much less or much more than a factor of 10.

order of reflection. The number of hops, or trips, to the ionosphere and back to earth, that a **radio wave** makes in traveling from one point to another.

ordinary ray. That magnetoionic wave component deviating the least, in most of its propagation characteristics, relative to those expected for a **wave** in the absence of the earth's magnetic field. More exactly, if at fixed electron density, the direction of the earth's magnetic field were rotated until its direction is transverse to the direction of phase propagation, the wave component whose propagation is then independent of the magnitude of the earth's magnetic field. Also called *ordinary-wave component.* See **magnetic double refraction, magnetoionic theory.**

ordinary wave component = **ordinary ray.**

organ. A portion or subassembly of a **computer** which constitutes the means of accomplishing some inclusive operation or function (e.g., arithmetic organ).

OR-gate. A **gate** whose output is energized when any one or more of the inputs is in its prescribed state. An OR-gate performs the

function of the logical *inclusive-OR*, of **Boolean algebra.**

Ori, Orio. International Astronomical Union abbreviations for *Orion.* See **constellation.**

origin. The reference from which measurement begins.

Orio. International Astronomical Union abbreviation for *Orion.* See **constellation.**

Orion (*abbr* **Ori, Orio**). See **constellation.**

orthochromatic. See **color sensitive,** note.

orthodrome = great circle.

orthogonal. Originally, at right angles; later generalized to mean the vanishing of a sum (or integral) of products.

The cosine of the angle between two vectors V_1 and V_2 with respective components x_1, y_1, z_1 and x_2, y_2, z_2 is proportional to the sum of products $x_1x_2 + y_1y_2 + z_1z_2$. Hence, if the vectors are perpendicular, the latter sum equals zero. For this reason any two series of numbers $(x_1, x_2, \ldots x_n)$ and $(y_1, y_2, \ldots y_n)$ is said to be orthogonal if

$$\Sigma\, x_i y_i = 0$$

orthogonal antennas. In radar, a pair of transmitting and receiving **antennas,** or a single transmitting-receiving antenna, designed for the detection of a difference in **polarization** between the transmitted energy and the energy returned from the target.

orthogonal curvilinear coordinates. See **curvilinear coordinates.**

orthogonal functions. A set of functions, any two of which, by analogy to orthogonal **vectors,** vanish if their product is summed by integration over a specified interval.

For example, $f(x)$ and $g(x)$ are orthogonal in the interval $x = a$ to $x = b$ if

$$\int_a^b f(x)g(x)\,dx = 0$$

The functions are also said to be normal if

$$\int_a^b [f(x)]^2 dx = \int_a^b [g(x)]^2 dx = 1$$

The most familiar examples of such functions, many of which have great importance in mathematical physics, are the sine and cosine functions between zero and 2π.

orthogonic. Pertaining to a state in which the spatial variations of a quantity have two planes of symmetry at right angles to each other.

osciducer. A **transducer** in which information pertaining to the stimulus is provided in the form of deviation from the center frequency of an **oscillator.**

oscillation. 1. Fluctuation or vibration on each side of a mean value or position. **2.** Half an oscillatory cycle, consisting of a fluctuation or vibration in one direction; half a vibration. **3.** The variation, usually with time, of the magnitude of a quantity with respect to a specified reference when the magnitude is alternately greater and smaller than the reference.

oscillator. A nonrotating device for producing alternating current.

oscillatory wave. A **wave** in which only the form advances, the individual particles moving in closed orbits, as ocean waves in deep water.

oscilloscope. 1. An instrument for producing a visual representation of **oscillations** or changes in an electric current. **2.** Specifically, a *cathode-ray oscilloscope.*

The face of the cathode-ray tube used for this representation is called a *scope* or *screen.*

osculating elements. The orbital **elements** of an **osculating orbit.**

osculating orbit. The **ellipse** that a satellite would follow after a specific time t (the **epoch** of osculation) if all forces other than central inverse-square forces ceased to act from time t on.

An osculating orbit is tangent to the real, perturbed, orbit and has the same velocity at the point of tangency.

otitic barotrauma = aero-otitis media.

otolith. A small calcareous concretion located in the inner ear which plays a part in the mechanism of orientation.

otolith organs. Structures of the inner ear (utricle and saccule) which respond to linear acceleration and tilting.

outer atmosphere. Very generally, the atmosphere at a great distance from the earth's surface; an approximate synonym for **exosphere.**

outer planets. The **planets** with orbits larger than that of Mars: Jupiter, Saturn, Uranus, Neptune, and Pluto.

outer product = vector product.

outgassing. The evolution of gas from a material in a **vacuum.**

out of phase. The condition of two or more **cyclic** motions which are not at the same part of their cycles at the same instant. Also called *out of step.* Compare **in phase.**

Two or more cyclic motions which are at the same part of their cycles at the same instant are said to be *in phase* or *in step.*

out of step = out of phase.

output. 1. The yield or product of an activity furnished by man, machine, or a system. **2.** Power or energy delivered by an engine, generator, etc. **3.** The electrical **signal** which emanates from a **transducer** and which is a function of the applied stimulus. Compare **input.**

The quantity represented by the signal may be given in terms of electrical units, frequency, or time.

output unit. In computer terminology, a unit which delivers information from the **computer** to an external device or from internal **storage** to external storage.

overall heat-transfer coefficient (*symbol* **U**). The value *U*, in British thermal units per hour per square foot per °F in the equation

$$Q = UA(t_1 - t_2)$$

where *Q* is heat flow per unit time; *A* is area; and *t* is temperature.

overexpanding nozzle. A **nozzle** in which the **fluid** is expanded to a lower pressure than the external pressure.

An overexpanding nozzle has an exit area larger than the optimum.

oxidant = **oxidizer.**

oxidizer (*symbol* **o,** used as subscript). Specifically, a substance (not necessarily containing oxygen) that supports the combustion of a **fuel** or **propellant.**

oximeter. An instrument for measuring the oxygen saturation of the blood.

oxygen bottle. A small container for pressurized oxygen used in life-support systems. See **bailout bottle.**

oxygen mask. A covering for the nose and lower face fitted with special attachments for breathing oxygen or a mixture of oxygen and other gases.

The oxygen mask has provision for separating the expired breath from the incoming oxygen.

oxygen paradox = **posthypoxia paradox.**

ozone layer = **ozonosphere.**

ozonosphere. The general stratum of the **upper atmosphere** in which there is an appreciable ozone concentration and in which ozone plays an important part in the radiation balance of the atmosphere. This region lies roughly between 10 and 50 kilometers, with maximum ozone concentration at about 20 to 25 kilometers. Also called *ozone layer.* See **atmospheric shell.**

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P

package. Any assembly or apparatus, complete in itself or practically so, identifiable as a unit and readily available for use or installation. See **power package.**

pad = **launch pad.**

pad deluge. Water sprayed upon certain **launch pads** during the launch of a rocket so as to reduce the temperatures of critical parts of the pad or the rocket. See **under-deck spray.**

paddlewheel satellite. A **satellite,** such as Explorer VI, that has solar vanes or similarly shaped objects attached.

pair production. An absorption process for **X-ray** and **gamma-ray** radiation in which the incident **photon** is annihilated in the vicinity of the nucleus of the absorbing atom, with subsequent production of an **electron** and **positron** pair.

This reaction does not occur for incident radiation energies of less than 1.02 million electron volts.

PAM (*abbr*) = ***pulse amplitude modulation.***

PAM/FM (*abbr*). **Frequency modulation** of a **carrier** by **pulses** which are **amplitude modulated** by information.

PAM/FM/FM (*abbr*). **Frequency modulation** of a **carrier** by **subcarrier**(s) which is (are) modulated by **pulses** which are **amplitude modulated** by information.

panchromatic. See **color sensitive,** note.

parabola. An open curve all points of which are equidistant from a fixed point, called the *focus*, and a straight line. See **conic section.**

The limiting case occurs when the point is on the line, in which case the parabola becomes a straight line.

parabolic. Pertaining to, or shaped like, a **parabola.**

parabolic orbit. An **orbit** shaped like a **parabola;** the orbit representing the least **eccentricity** (that of 1) for **escape** from an attracting body.

parabolic reflector. A reflecting surface having the cross section along the axis in the shape of a **parabola.** See **corner reflector, radar reflector, scanner.**

Parallel rays striking the reflector are brought to a focus at a point, or if the source of the rays is placed at the focus, the reflected rays are parallel.

paraboloid. A surface of revolution generated by revolving a section **of a parabola about** its **major axis.**

paraboloidal. Pertaining to, or shaped like, a **paraboloid.**

parabrake = **deceleration parachute.**

parafoveal vision. Vision in which the eye is so oriented toward the pertinent light source as to have the light fall upon some portion of the retina surrounding the **fovea.** Also called *scotopic vision.* See **foveal vision.**

The portion of the retina used in this type of vision contains receptors known as *rods*. Although these rods do not permit the sort of color-sensing vision possible with the cones in the central or foveal region of the retina, they have the useful property of responding to very low illuminance, particularly after dark adaptation is complete. Nighttime vision is performed primarily with the rods.

parallactic angle. The angle between a body's **hour circle** and its **vertical circle.** Also called *position angle.*

parallactic inequality. A secondary effect in the solar **perturbations** in the moon's longitude due to the ellipticity of the earth's orbit.

parallax. The difference in the apparent direction or position of an object when viewed from different points expressed as an angle.

For bodies of the solar system, parallax is measured from the surface of the earth and its center and is called *geocentric parallax*, varying with the body's altitude and distance from the earth. The geocentric parallax when a body is in the horizon is called *horizontal parallax* and is the angular semidiameter of the earth as seen from the body. Parallax of the moon is called *lunar parallax.* For stars, parallax is measured from the earth and the sun, and is called *annual, heliocentric,* or *stellar parallax.* Compare **aberration.**

parallax error. The error in measurement between two pairs of **antenna** caused by the fact that the center of the two **baselines** do not coincide.

This error is a function of the distance of the target from the baseline, as well as its relative direction.

parallax in altitude. Geocentric parallax of a body at any altitude.

The expression is used to distinguish the parallax at the given altitude from the horizontal parallax.

parallax second. See **parsec.**

parallel. A circle on the surface of the earth, parallel to the plane of the **equator** and connecting all points of equal **latitude,** or a circle parallel to the **primary great circle** of a sphere or spheroid; also a closed curve approximating such a circle. Also called *parallel of latitude, circle of longitude.* See **coordinate,** table.

An astronomical parallel is a line connecting points having the same astronomical latitude. A goedetic parallel is a line connecting points of equal geodetic latitude. Geodetic and sometimes astronomical parallels are also called geographic parallels. Geodetic parallels are shown on charts. A standard parallel is one along which the scale of a chart is as stated. A fictitious, grid, transverse, inverse, or oblique parallel is parallel to a fictitious, grid, transverse, inverse, or oblique equator, respectively. A magnetic parallel is a line connecting points of equal magnetic dip.

parallel of altitude. A circle of the **celestial sphere** parallel to the **horizon** connecting all points of equal altitude. Also called *altitude circle, almucantar.* See **circle of equal altitude.**

parallel of declination. A circle of the **celestial sphere** parallel to the **celestial equator.** Also called *circle of equal declination.* See **diurnal circle.**

parallel of latitude. **1.** A circle (or approximation of a circle) on the surface of the earth, parallel to the **equator,** and connecting points of equal **latitude.** Also called *parallel.* **2.** A circle of the **celestial sphere,** parallel to the **ecliptic,** and connecting points of equal **celestial latitude.** Also called *circle of longitude.*

paramagnetic. Having a **magnetic permeability** greater than unity.

parameter. **1.** In general, any quantity of a problem that is not an **independent variable.** More specifically, the term is often used to distinguish, from dependent variables, quantities which may be assigned more or less arbitrary values for purposes of the problem at hand. **2.** In statistical terminology, any numerical constant derived from a population or a probability distribution. Specifically, it is an arbitrary constant in the mathematical expression of a probability distribution. For example, in the distribution given by

$$f(x) = \alpha e^{-\alpha x}$$

the constant α is a parameter. **3.** In *celestial mechanics,* the **semi-latus rectum.**

parameterization. The representation, in a mathematical model, of physical effects in terms of admittedly oversimplified **parameters,** rather than realistically requiring such effects to be consequences of the dynamics of the system.

Parameterization is often used in systems analysis to determine the effect on the system of changing one parameter while holding other parameters constant.

parametric equations. A set of equations in which the **independent variables** or coordinates are each expressed in terms of a parameter.

For example, instead of investigating $y = f(x)$ or $F(x,y) = 0$ it is often advantageous to express both x and y in terms of a parameter u: $x = g(u)$; $y = G(u)$. The parameter may or may not have a useful geometric or physical interpretation.

parasitic element. A radiating element, not coupled directly to the **feed** line of the **antenna,** which materially affects the pattern of the antenna.

parcel = **fluid parcel.**

Pardop (*abbr*) = ***pa**ssive **r**anging **Dop**pler* **system.**

parent. A **radionuclide** that upon disintegration yields a specified **nuclide,** the daughter, either directly or as a later member of a radioactive series.

Thus, U^{238} is the parent of all members of the uranium series, including the end product, Pb^{206}.

parity. A symmetry property of a **wave function.**

The parity is 1 (or even) if the wave function is unchanged by an inversion (reflection in the origin) of the coordinate system; it is -1 (or odd) if the wave function is changed only in sign.

parity bit. A **bit** added to a binary code group which is used to indicate whether the number of recorded 1 or 0 is even or odd.

parking orbit. An **orbit** of a **spacecraft** around a celestial body, used for assembly of components or to wait for conditions favorable for departure from the orbit.

parsec (*abbr* **pc**). A unit of length equal to the distance from the sun to a point having a **heliocentric parallax** of 1 second (1″), used as a measure of stellar distance.

The name parsec is derived from the words *par*allax *sec*ond. 1 parsec = pc = 3.084×10^{13} kilometers
= 206,265 astronomical units
= 3.262 light years

part. **1.** One of the constituents into which a thing may be divided. Applicable to a major **assembly, subassembly,** or the smallest individual piece in a given thing. **2.** Restrictive. The least subdivision of a thing; a piece that functions in interaction with other elements of a thing, but is itself not ordinarily subject to disassembly.

partial-admission turbine. A type of **turbine** in which the working substance is directed only through part of the annular area swept by the rotating turbine blades.

partial correlation. The **correlation** between the residuals of two random variables with respect to common regressors. Denoting the regression function of two variates y and z with respect to a common set of regressors $x_1, x_2, \cdots x_n$ by Y and Z; the coefficient of partial correlation between y and z is defined

as the coefficient of simple, linear correlation between $(y - Y)$ and $(z - Z)$. See **regression.**

partial derivative. The ordinary **derivative** of a function of two or more variables with respect to one of the variables, the others being considered constants. If the variables are x and y, the partial derivatives of $f(x, y)$ are written $\partial f/\partial x$ and $\partial f/\partial y$, or $D_x f$ and $D_y f$, or f_x and f_y.

The partial derivative of a variable with respect to time is known as the *local derivative.*

partial node. A point, line, or surface in a **standing wave** system where some characteristic of the wave field has a minimum amplitude differing from zero.

The appropriate modifier should be used with the words *partial node* to signify the type that is intended; e.g., *displacement partial node, velocity partial node, pressure partial node.*

partial lunar eclipse. See **lunar eclipse,** note.

partial pressure. The **pressure** exerted by a designated component or components of a gaseous mixture.

This may be separately measured in some cases by suitable selection of gages, traps, or analytical trains. When the percentage composition of the mixture is known, the partial pressure may be calculated from the total pressure by **Dalton law of partial pressures.**

partial pressure suit. A skintight suit which does not completely enclose the body but which is capable of exerting pressure on the major portion of the body in order to counteract an increased oxygen pressure in the lungs.

partial solar eclipse. See **solar eclipse.**

particle. 1. An elementary subatomic particle such as proton, electron, neutron, etc. **2.** A very small piece of matter. **3.** In celestial mechanics, a hypothetical entity which responds to gravitational forces but which exerts no appreciable gravitational force on other bodies, thus simplifying orbital computations.

particle accelerator. Specifically a device for imparting large **kinetic energy** to charged particles, such as **electrons, protons, deuterons,** and helium ions.

Common types of accelerators are the cyclotron, synchrotron, synchrocyclotron, betatron, linear accelerator, and Van de Graaff electrostatic accelerator.

Paschen law. A theoretical relationship for the direct-current breakdown voltage of two parallel-plane electrodes immersed in a gas as a function of the gas pressure and electrode separation. This relationship predicts the occurrence of a minimum breakdown voltage for a certain product of the pressure times the separation.

The phenomenon is well verified experimentally and is referred to as the *Paschen minimum.* This minimum voltage is on the order of 300 to 500 volts and, for a gas pressure of 1 millimeter of mercury, occurs at an electrode separation of 0.2 to 1 centimeter depending on the gas.

Paschen minimum. See **Paschen law,** note.

pass. 1. A single circuit of the earth by a **satellite.** Passes start at the time the satellite crosses the equator from the southern hemisphere into the northern hemisphere (the ascending node). See **orbit. 2.** The period of time the satellite is within **telemetry** range of a **data acquisition station.**

passive. Containing no power sources to augment output power, e.g., *passive electrical network, passive reflector* (as in the Echo satellite). Applied to a device that draws all its power from the **input signal.** Compare **active.**

passive homing. The **homing** of an aircraft or spacecraft wherein the craft directs itself toward the target by means of energy waves transmitted or radiated by the target. See **active homing.**

passive homing guidance. Guidance in which a craft or missile is directed toward a destination by means of natural radiations from the destination.

passive ranging Doppler system (*abbr* **Pardop**). A **trajectory-measuring system** similar to **Dovap** except that no **transponder** is used in the missile.

Space position is computed from several **loop** ranges between the transmitter, missile, and receivers.

path. 1. Of a satellite, the projection of the orbital plane on the earth's surface, the locus of the satellite **subpoint.**

Since the earth is turning under the satellite, the path of a single orbital pass will not be a closed curve. *Path* and *track* are used interchangeably. On a cylindrical map projection, the path is a sine-shaped curve.

2. Of a meteor, the projection of the **trajectory** on the **celestial sphere,** as seen by the observer. **3.** = **flightpath.**

Pav, Pavo. International Astronomical Union abbreviations for *Pavo.* See **constellation.**

Pavo (*abbr* **Pav, Pavo**). See **constellation.**

payload. 1. Originally, the revenue-producing portion of an aircraft's load, e.g., passengers, cargo, mail, etc. **2.** By extension, that which an aircraft, rocket, or the like carries over and above what is necessary for the operation of the vehicle for its flight.

payload mass ratio (*symbol* ζ). Of a **rocket,** the ratio of the effective propellant mass m_p to the initial vehicle mass m_o or

$$\zeta = m_p/m_o$$

Also called *mass ratio.*

P-band. A frequency band used in **radar** extending approximately from 225 to 390 megacycles per second. See **frequency bands.**

PCM (*abbr*) = **pulse code modulation.**

PCM/FM (*abbr*). **Frequency modulation** of a **carrier** by **pulse-code-modulated** information.

PCM/FM/FM (*abbr*). **Frequency modulation** of a **carrier** by **subcarrier(s)** which is (are) frequency modulated by **pulse-code-modulated** information.

PCM/PM (*abbr*). **Phase modulation** of a **carrier** by **pulse-code-modulated** information.

P-display = **plan position indicator.**

PDM (*abbr*) = **pulse duration modulation.**

PDM/FM (*abbr*). **Frequency modulation** of a **carrier** by **pulses** which are modulated in duration by information.

PDM/FM/FM (*abbr*). **Frequency modulation** of a **carrier** by **subcarrier(s)** which is (are) frequency modulated by **pulses** which are modulated in duration by information.

PDM/PM (*abbr*). **Phase modulation** of a **carrier** by **pulses** which are modulated in duration by information.

peak sound pressure. For any specified time interval, the maximum absolute value of the instantaneous **sound pressure** in that interval.

In the case of a periodic wave, if the time interval considered is a complete period, the peak sound pressure becomes identical with the maximum sound pressure.

peak-to-peak value. Of an oscillating quantity, the algebraic difference between the extremes of the quantity.

Péclet number (*symbol* N_{Pe}). A nondimensional number arising in problems of heat transfer in **fluids.** It is the ratio of heat advection to heat diffusion and may be written

$$NP_e = Ul/k$$

where U is a characteristic velocity; l is a characteristic length; and k is the thermometric conductivity. Also,

$$N_{Pe} = N_{Re}N_{Pr}$$

where N_{Re} is the **Reynolds number** and N_{Pr} is the **Prandtl number.**

Peg, Pegs. International Astronomical Union abbreviations for *Pegasus.* See **constellation.**

Pegasus (*abbr* **Peg, Pegs**). See **constellation.**

Pegs. International Astronomical Union abbreviation for *Pegasus.* See **constellation.**

Peltier effect. The production or absorption of heat at the junction of two metals on the passage of an electrical current.

Heat generated by current flowing in one direction will be absorbed if the current is reversed. This effect is presently being extensively studied as a possible energy conversion method for space vehicles.

pencil beam. Emission, from an **antenna,** having the form of a narrow **conical beam.**

pencil-beam antenna. A **unidirectional antenna,** so designed that cross sections of the **major lobe** by planes perpendicular to the direction of maximum radiation are approximately circular, and having a very small angular cross section.

Penning discharge. A direct-current **discharge** where electrons are forced to oscillate between two opposed cathodes and are restrained from going to the surrounding anode by the presence of a magnetic field.

It is sometimes referred to as a *pig* discharge since the device was originally used as an ionization gage (*P*enning *i*onization *g*age). It is used as a plasma-beam source by permitting the **plasma** to stream out along the magnetic field through a hole in one of the cathodes.

Penning effect. An increase in the effective **ionization** rate of a gas due to the presence of a small number of foreign **metastable** atoms.

For instance, a neon atom has a metastable level at 16.6 volts and if there are a few neon atoms in a gas of argon which has an ionization potential of 15.7 volts, a collision between the neon metastable atom with an argon atom may lead to ionization of the argon. Thus, the energy which is stored in the metastable atom can be used to increase the ionization rate. Other gases where this effect is used are helium, with a metastable level at 19.8 volts, and mercury, with an ionization level at 10.4 volts.

Penning gage. See **cold-cathode ionization gage,** note.

penumbra. See **umbra.**

penumbral eclipse. See **lunar eclipse,** note.

Per, Pers. International Astronomical Union abbreviations for *Perseus.* See **constellation.**

perfect fluid. In simplifying assumptions, a **fluid** chiefly characterized by lack of viscosity and, usually, by incompressibility. Also called an *ideal fluid, inviscid fluid.* See **perfect gas.**

A perfect fluid is sometimes further characterized as homogeneous and continuous.

perfect gas. A gas which has the following characteristics: (a) it obeys the **Boyle-Mariotte law** and the **Charles-Gay-Lussac law,** thus satisfying the equation of state for perfect gases; (b) it has internal energy as a function of temperature alone; and (c) it has specific heats with values independent of temperature. Also called *ideal gas.* Compare **perfect fluid.**

The normal volume of a perfect gas is 2.24136×10^4 centimeters cubed per mole.

perfect-gas laws = **gas laws.**

perfectly diffuse radiator. A body that emits **radiant energy** in accordance with **Lambert law.** The **radiant intensity** emitted in any direction from a unit area of such a radiator varies as the cosine of the angle between the normal to the surface and the direction of the

radiation. Compare **diffuse radiation, isotropic radiator.**

When viewed from a distance, an incandescent perfectly diffuse radiator appears as a uniformly illuminated flat surface regardless of its actual shape or orientation.

perfectly diffuse reflector. A body that reflects **radiant energy** in such a manner that the reflected energy may be treated as if it were being emitted (radiated) in accordance with **Lambert law.** The radiant intensity reflected in any direction from a unit area of such a reflector varies as the cosine of the angle between the normal to the surface and the direction of the reflected radiant energy.

perfect radiator = black body.

perfect vacuum = absolute vacuum.

peri. A prefix meaning *near* as in *perigee.*

periapsis. The orbital point nearest the center of attraction. See **orbit.**

periastron. That point of the **orbit** of one member of a **binary** star system at which the stars are nearest to each other.

That point at which they are farthest apart is called *apastron.*

pericynthian. That point in the **trajectory** of a vehicle which is closest to the moon.

perifocus. The point on an **orbit** nearest the dynamical center (**focus**). The pericenter is at one end of the **major axis** of the oribital **ellipse.**

perigee. That orbital point nearest the earth when the earth is the center of attraction. See **orbit.**

That orbital point farthest from the earth is called *apogee.* Perigee and apogee are used by some writers in referring to orbits of satellites, especially artificial satellites, around any planet or satellite, thus avoiding coinage of new terms for each planet and moon.

perigee propulsion. A programed-thrust technique for **escape** from a planet, which uses intermittent applications of thrust at perigee (when vehicle velocity is high) and coasting periods.

perigee speed. The speed of an orbiting body when at **perigee.**

perigee-to-perigee period = *anomalistic* period.

perihelion. That point in a solar **orbit** which is nearest the sun.

That orbital point farthest from the sun is called *aphelion.* The term *perihelion* should not be confused with *parhelion,* a form of halo.

period. 1. The interval needed to complete a **cycle.** 2. = **orbital period.** 3. Specifically, the interval between passages at a fixed point of a given **phase** of a simple **harmonic** wave; the reciprocal of **frequency.** 4. The time interval during which the power level (flux) of a **reactor** changes by a factor of *e* (2.718, the base of natural logarithms).

periodic quantity. In mathematics, an oscillating quantity whose values recur for certain increments of the **independent variable.**

periodic terms. See **secular terms,** note.

period of moon's node. See **nutation,** note.

period scrams. Electronic safety circuits that automatically insert safety rods in a **reactor** when the reactor **period** decreases below the safe minimum limit.

periscope. An optical instrument which displaces the **line of sight** parallel to itself to permit a view which may otherwise be obstructed.

periscopic. Of or pertaining to a periscope, as in *periscopic sextant.*

permanent magnetism. Magnetism which is retained for long periods without appreciable reduction, unless the magnet is subjected to demagnetizing force. See **induced magnetism.**

Because of the slow dissipation of such magnetism, it is sometimes called *subpermanent magnetism,* but the expression *permanent magnetism* is considered preferable.

permanent memory. In computer terminology, **storage** of information which remains intact when the power is turned off. Also called *nonvolatile storage.*

permeability. 1. Of a magnetic material, the ratio of the **magnetic induction** to the **magnetic-field intensity** in the same region. 2. The ability to permit penetration or passage. In this sense the term is applied particularly to substances which permit penetration or passage of **fluids.** 3. = **permeability coefficient.**

permeability coefficient. The steady-state rate of flow of **gas** through unit area and thickness of a solid barrier per unit pressure differential at a given temperature. Also called *permeability.*

Usually expressed in volume or mass per unit time, per unit area of cross section, per unit thickness, per unit pressure differential across the barrier.

permeation. As applied to gas flow through solids, the passage of **gas** into, through, and out of a solid barrier having no holes large enough to permit more than a small fraction of the gas to pass through any one hole. The process always involves **diffusion** through the solid and may involve various surface phenomena, such as **sorption, dissociation, migration,** and **desorption** of the gas molecules.

permissible dose. The amount of **radiation** which may be received by an individual within a specified period with expectation of no harmful result to himself.

Pers. International Astronomical Union abbreviation for *Perseus.* See **constellation.**

Perseus (*abbr* **Per, Pers**). See **constellation.**

persistent train. A meteor train which endures for an appreciable length of time.

perturbation. **1.** Any departure introduced into an assumed **steady state** of a system, or a small departure from a nominal path such as a desired trajectory. Usually used as equivalent to **small perturbation.** **2.** Specifically, a disturbance in the regular motion of a **celestial body,** the result of a force additional to that which causes the regular motion, specifically, a gravitational force.

perturbation method = **method of small perturbation.**

perturbation quantity. Any parameter of a system, e.g., velocity components or temperature, which may or may not have been assumed to be small perturbations from a mean or **steady-state** value.

PFM (*abbr*) = ***p*ulse *f*requency *m*odulation.**

phase. **1.** Of a **periodic quantity,** for a particular value of the independent variable, the fractional part of a **period** through which the independent variable has advanced, measured from an arbitrary reference.

The arbitrary reference is generally so chosen that the fraction is less than unity. In case of a **simple harmonic quantity,** the reference is often taken as the last previous passage through zero from the negative to positive direction.

Thus, if two waves crest one-fourth cycle apart, they are said to be *90° apart in phase*, or *90° out of phase.* The moon is said to be at *first quarter* when it has completed one-fourth of its cycle from new moon.

2. The state of aggregation of a substance, for example solid, liquid, or gas. **3.** The extent to which the disk of the moon or a planet, as seen from the earth, is illuminated or not illuminated by the sun. **4.** In astronomy = **configuration.**

phase angle. **1.** The **phase** difference of two periodically recurring phenomena of the same **frequency,** expressed in angular measure. **2.** The angle at a **celestial body** between the sun and earth.

phase constant. See **propagation constant.**

phase detector. A device that continuously compares the **phase** of two signals and provides an output proportional to their difference in phase.

phase deviation. The peak difference between the instantaneous **phase** of the **modulated** wave and the **carrier** frequency.

The extent of deviation is proportional to the amplitude of the modulating signal.

phase front. A surface of constant **phase** (or phase angle) of a propagating **wave** disturbance. Also called *wave front.*

Generally, phase fronts spread out spherically from their source; but in cases where energy is assumed to travel in parallel rays (as in many radiation problems), phase fronts may be approximated as plane surfaces oriented perpendicularly to the rays.

phase lock. The technique of making the **phase** of an **oscillator** signal follow exactly the phase of a reference signal by comparing the phases between the two signals and using the resultant difference signal to adjust the frequency of the reference oscillator. See **correlation detection.**

phase-lock loop. An electronic **servo** system incorporating **phase lock** and used either as a tracking filter or as a frequency discriminator.

phase modulation (*abbr* **PM**). **Angle modulation** in which the angle of a sine-wave carrier is caused to depart from the **carrier** angle by an amount proportional to the instantaneous value of the **modulating wave.**

Combinations of phase and frequency modulation are commonly referred to as *frequency modulation.*

phase-shaped antenna = **shaped-beam antenna.**

phases of the moon. The various appearances of the moon during different parts of the **synodical month.**

The cycle begins with new moon or change of the moon at **conjunction.** The visible part of the waxing moon increases in size during the first half of the cycle until full moon appears at **opposition,** after which the visible part of the waning moon decreases for the remainder of the cycle. First quarter occurs when the waxing moon is at east **quadrature;** last quarter when the waning moon is at west quadrature. From last quarter to new and from new to first quarter, the moon is crescent; from first quarter to full and from full to last quarter, it is **gibbous.** The elapsed time, usually expressed in days since the last new moon, is called *age of the moon.*

phase space. The sum of the three dimensions of ordinary space and the three dimensions of velocity space. See **distribution function.**

phase speed = **phase velocity.**

phase velocity. Of a **traveling plane wave** at a single **frequency,** the velocity of an equiphase surface along the wave normal. Also called *phase speed, wave speed, wave velocity.*

Thus, the component $\sin (2\pi/\lambda)\ (x - ct)$ represents a wavelength λ traveling in the positive x-direction with phase velocity c. This concept is to be distinguished from signal velocity, group velocity, and the velocity of fluid parcels. See **velocity of propagation.**

Phe, Phoe. International Astronomical Union abbreviations for *Phoenix.* See **constellation.**

Philips gage. A cold-cathode type of **vacuum gage** wherein an electrical discharge is main-

tained in the presence of a superposed magnetic field in order to increase the ionization current. See **cold-cathode ionization gage.**

Phobos. A **satellite** of Mars orbiting at a mean distance of 9,400 kilometers.

Phoe. International Astronomical Union abbreviation for *Phoenix.* See **constellation.**

Phoebe. A **satellite** of Saturn orbiting at a mean distance of 12,960,000 kilometers.

Phoenix (*abbr* **Phe, Phoe**). See **constellation.**

phon. The unit of loudness **level** of sound, numerically equal to the **sound pressure** level in decibels, relative to 0.0002 microbar, of a simple 1000 cycle per second tone judged by listeners to be equivalent in loudness. Compare **sone.**

phonometer. An instrument for measuring the **intensity** or **frequency** of sounds.

phosphor. A phosphorescent substance, such as zinc sulfide, which emits light when excited by radiation, as on the scope of a cathode-ray tube. See **phosphorescence.**

phosphorescence. Emission of light which continues after the exciting mechanism has ceased. See **luminescence.** Compare **fluorescence.**

An example of phosphorescence is the glowing of an oscilloscope screen after the exciting beam of electrons has moved to another part of the screen.

phot. A photometric unit of **illuminance** or **illumination** equal to 1 lumen per square centimeter. Compare **foot-candle, lux.**

photocathode. An **electrode** used for obtaining **photoelectric emission.**

photocell = photoelectric cell.

photochemical reaction. A chemical reaction which involves either the **absorption** or **emission** of **radiation.**

photoconductive cell. A **photoelectric** cell whose electrical resistance varies with the amount of illumination falling upon the sensitive area of the cell.

photodissociation. The dissociation (splitting) of a molecule by the absorption of a **photon.** The resulting components may be **ionized** in the process (photoionization).

photoelectric. 1. Pertaining to the **photoelectric effect. 2.** Using a **photoelectric cell,** as a *photoelectric photometer.*

photoelectric cell. A **transducer** which converts **electromagnetic radiation** in the infrared, visible, and ultraviolet regions into electrical quantities such as voltage, current, or resistance. Also called *photocell.* See **photoelectric effect.**

photoelectric effect. The **emission** of an **electron** from a surface as the surface absorbs a **photon** of electromagnetic radiation. Electrons so emitted are termed *photoelectrons.*

The effectiveness of the process depends upon the surface metal concerned and the wavelength of the radiant energy to which it is exposed. Cesium, for example, will emit electrons when exposed to visible radiation. The energy of the electron produced is equal to the energy of the incident photon minus the amount of work needed to raise the electron to a sufficient energy level to free it from the surface. The resultant energy of the electron, therefore, is proportional to the frequency (i.e., inversely proportional to the wavelength) of the incident radiation.

photoelectric emission. See **photoelectric effect.**

photoelectric photometry. Photometry in which a **photoelectric cell** is used as the sensing element.

photoelectric transducer. A **transducer** which converts changes in light energy to changes in electrical energy.

photoelectron. An **electron** which has been ejected from its parent atom by interaction between that atom and a high-energy **photon.**

Photoelectrons are produced when electromagnetic radiation of sufficiently short wavelength is incident upon metallic or other solid surfaces (photoelectric effect) or when radiation passes through a gas.

photogrammetry. The art or science of obtaining reliable measurements by means of photography.

photographic magnitude (*symbol* m_{pg}). Stellar **magnitudes** measured from a photographic plate exposed without filters.

Photographic plates are more sensitive to short wavelengths than the human eye. The zero point of the photographic magnitude scale is such that photographic (m_{pg}) and visual (m_v) magnitudes are the same for stars of class A0 of magnitudes between 5.5 and 6.5.

Photovisual magnitudes (m_{pv}) are measured from plates exposed through filters which hold back blue and violet thus giving magnitudes in the plate which closely approximate visual magnitudes (m_v).

photographic meteor. A **meteor** of brightness sufficient to be detected by photography.

photographic transmission density. The common logarithm of **opacity.** Hence, film transmitting 100 percent of the light has a density of zero, transmitting 10 percent, a density of 1, etc. Density may be diffuse, specular, or intermediate. Conditions must be specified. Also called *optical density.*

Diffuse transmission density is the value of the photographic transmission density obtained when the light flux impinges normally on the sample and all the transmitted flux is collected and measured.

Specular transmission density is the value of the photographic density obtained when the light flux impinges normally on the sample and only the normal component of the transmitted flux is collected and measured.

photoionization. The **ionization** of an atom or molecule by the collision of a high-energy **photon** with the particle. See **photoelectron.**

photology. The study of **light.**

photoluminescence = **fluorescence,** see **luminescence.**

photometer. An instrument for measuring the **intensity** of light or the relative intensity of a pair of lights. Also called *illuminometer.*

If the instrument is designed to measure the intensity of light as a function of wavelength, it is called a *spectrophotometer.* Photometers may be divided into two classes: photoelectric photometers in which a photoelectric cell is used to compare electrically the intensity of an unknown light with that of a standard light, and visual photometers in which the human eye is the sensor.

photometry. The study of the measurement of the **intensity** of light.

At one time *photometry* referred only to the measurement of **luminous intensity,** intensity of light in the wavelengths to which the eye is sensitive. This restriction has proved difficult to maintain in practice.

photomultiplier = **multiplier phototube.**

photon. According to the **quantum theory** of **radiation,** the elementary quantity, or quantum, of radiant energy. It is regarded as a discrete quantity having a momentum equal to $h\nu/c$, where h is Planck constant, ν is the frequency of the radiation, and c is the speed of light in a vacuum. The photon is never at rest, has no electric charge and no magnetic moment, but does have a spin moment. The energy of a photon (the unit quantum of energy) is equal to $h\nu$.

photon engine. A projected type of **reaction engine** in which thrust would be obtained from a stream of **electromagnetic radiation.** Compare **ion engine.**

Although the thrust of this engine would be minute, it may be possible to apply it for extended periods of time. Theoretically, in space, where no resistance is offered by air particles, very high speeds may be built up.

photon gas. A radiation field.

photon rocket. A **photon engine;** a rocket vehicle powered by a photon engine.

photopic vision. Vision associated with levels of illumination 0.01 foot-lambert or higher, characterized by the ability to distinguish colors and small detail. Also called *foveal vision.* Compare **scotopic vision.**

photosphere. The intensely bright portion of the sun visible to the unaided eye.

The photosphere is that portion of the sun's atmosphere which emits the continuum radiation upon which the **Fraunhofer lines** are superimposed. In one sun model, the photosphere is thought to be below the reversing layer in which Fraunhofer absorption takes place. In another model, all strata are considered equally effective in producing continuous emissions and line absorption.

photosynthesis. A process operating in green plants in which carbohydrates are formed under the influence of light with chlorophyl serving as a catalyst. See **closed ecological system.**

phototheodolite. An instrument or device incorporating one or more cameras for taking and recording angular measurements.

The phototheodolite, sometimes in conjunction with radar equipment, is used to track rockets and to measure and record attitude, altitude, azimuth and elevation angles, etc.

phototube. An **electron tube** that contains a **photocathode** and has an output depending on the total photoelectric emission from the irradiated area of the photocathode.

photovisual magnitude. See **photographic magnitude,** note.

photovoltaic cell. A **transducer** which converts **electromagnetic radiation** into electric current.

The solar cells used on satellites and space probes are photovoltaic cells employing a semiconductor such as

TABLE VIII.—DEFINED VALUES AND EQUIVALENTS (RECOMMENDED BY NAS-NRC, 1963)

Unit	Abbreviation	Value
Meter	m	1,650,763.73 wavelengths in vacuo of the unperturbed transition $2p_{10}$—$5d_5$ in Kr^{86}
Kilogram	kg	mass of the international kilogram at Sèvres, France
Second	s	1/31,556,925.974 7 of the tropical year at 12^h ET, 0 January 1900
Degree Kelvin	°K	defined in the thermodynamic scale by assigning 273.16 °K to the triple point of water (freezing point, 273.15 °K = 0 °C)
Unified atomic mass unit	u	1/12 the mass of an atom of the C^{12} nuclide
Mole	mol	amount of substance containing the same number of atoms as 12g of pure C^{12}
Standard acceleration of free fall	g_n	9.806 65 m s^{-2}, 980.665 cm s^{-2}
Normal atmospheric pressure	atm	101 325 N m^{-2}, 1 013 250 dyn cm^{-2}
Thermochemical calorie	cal_{th}	4.1840 J, 4.1840 × 10^7 erg
International Steam Table calorie	cal, T	4.1868 J, 4.1868 × 10^7 erg
Liter	l	0.001 000 028 m^3, 1 000.028 cm^3 (recommended by CIPM, 1950)
Inch	in.	0.0254 m, 2.54 cm
Pound (avdp.)	lb	0.453 592 37 kg, 453.592 37 g

Photonics. That branch of physics that treats of the emission, transmission, behavior, and effects of photons. The field of photonics begins, for example, when a laser diode converts an electronic signal into a photon beam. Photonic functions rep[lace] the electronic functions: propagation, deflection, modulation, amplification + storage of light.

silicon which releases electrons when bombarded by photons from solar radiation.

phugoid oscillation. In a flightpath, a long-period longitudinal **oscillation** consisting of shallow climbing and diving motions about a median **flightpath** and involving little or no change in angle of attack.

physical constant. An abstract number or physically dimensional quantity having a fixed or approximately fixed value; a universal and permanent value, as the constant of gravitation; a characteristic of a substance, as the refractive index of a liquid.

A new, consistent set of values for physical constants, which has been recommended by the National Academy of Sciences-National Research Council in 1963, is presented in tables VIII, IX, and X.

TABLE IX.—ADJUSTED VALUES OF PHYSICAL CONSTANTS (RECOMMENDED BY NAS-NRC, 1963)

Constant	Symbol	Value	Est. ‡ error limit	Unit: Système International (MKSA)		Unit: Centimeter-gram-second (CGS)	
Speed of light in vacuum	c	2.997925	3	$\times10^{8}$	$m\ s^{-1}$	$\times10^{10}$	$cm\ s^{-1}$
Elementary charge	e	1.60210	7	10^{-19}	C	10^{-20}	$cm^{1/2}g^{1/2}$ *
		4.80298	20	....	....	10^{-10}	$cm^{3/2}g^{1/2}s^{-1}$ †
Avogadro constant	N_A	6.02252	28	10^{23}	mol^{-1}	10^{23}	mol^{-1}
Electron rest mass	m_e	9.1091	4	10^{-31}	kg	10^{-28}	g
		5.48597	9	10^{-4}	u	10^{-4}	u
Proton rest mass	m_p	1.67252	8	10^{-27}	kg	10^{-24}	g
		1.00727663	24	10^{0}	u	10^{0}	u
Neutron rest mass	m_n	1.67482	8	10^{-27}	kg	10^{-24}	g
		1.0086654	13	10^{0}	u	10^{0}	u
Faraday constant	F	9.64870	16	10^{4}	$C\ mol^{-1}$	10^{3}	$cm^{1/2}g^{1/2}mol^{-1}$ *
		2.89261	5	....	....	10^{14}	$cm^{3/2}g^{1/2}s^{-1}mol^{-1}$ †
Planck constant	h	6.6256	5	10^{-34}	J s	10^{-27}	erg s
		1.05450	7	10^{-34}	J s	10^{-27}	erg s
Fine structure constant	α	7.29720	10	10^{-3}	....	10^{-3}	
	$1/\alpha$	1.370388	19	10^{2}	....	10^{2}	
	$\alpha/2\pi$	1.161385	16	10^{-3}	....	10^{-3}	
	α^2	5.32492	14	10^{-5}	....	10^{-5}	
Charge to mass ratio for electron	e/m_e	1.758796	19	10^{11}	$C\ kg^{-1}$	10^{7}	$cm^{1/2}g^{-1/2}$ *
		5.27274	6	....	....	10^{17}	$cm^{3/2}g^{-1/2}s^{-1}$ †
Quantum-charge ratio	h/e	4.13556	12	10^{-15}	$J\ s\ C^{-1}$	10^{-7}	$cm^{3/2}g^{1/2}s^{-1}$ *
		1.37947	4	....	....	10^{-17}	$cm^{1/2}g^{1/2}$ †
Compton wavelength of electron	λ_C	2.42621	6	10^{-12}	m	10^{-10}	cm
	$\lambda_C/2\pi$	3.86144	9	10^{-13}	m	10^{-11}	cm
Compton wavelength of proton	$\lambda_{C,p}$	1.32140	4	10^{-15}	m	10^{-13}	cm
	$\lambda_{C,p}/2\pi$	2.10307	6	10^{-16}	m	10^{-14}	cm
Rydberg constant	R_∞	1.0973731	3	10^{7}	m^{-1}	10^{5}	cm^{-1}
Bohr radius	a_0	5.29167	7	10^{-11}	m	10^{-9}	cm
Electron radius	r_e	2.81777	11	10^{-15}	m	10^{-13}	cm
	r_e^2	7.9398	6	10^{-30}	m^2	10^{-26}	cm^2
Thomson cross section	$8\pi r_e^2/3$	6.6516	5	10^{-29}	m^2	10^{-25}	cm^2
Gyromagnetic ratio of proton	γ	2.67519	2	10^{8}	$rad\ s^{-1}T^{-1}$	10^{4}	$rad\ s^{-1}G^{-1}$ *
	$\gamma/2\pi$	4.25770	3	10^{7}	$Hz\ T^{-1}$	10^{3}	$s^{-1}G^{-1}$ *
(uncorrected for diamagnetism, H_2O)	γ'	2.67512	2	10^{8}	$rad\ s^{-1}T^{-1}$	10^{4}	$rad\ s^{-1}G^{-1}$ *
	$\gamma'/2\pi$	4.25759	3	10^{7}	$Hz\ T^{-1}$	10^{3}	$s^{-1}G^{-1}$ *
Bohr magneton	μ_B	9.2732	6	10^{-24}	$J\ T^{-1}$	10^{-21}	$erg\ G^{-1}$ *
Nuclear magneton	μ_N	5.0505	4	10^{-27}	$J\ T^{-1}$	10^{-24}	$erg\ G^{-1}$ *
Proton moment	μ_p	1.41049	13	10^{-26}	$J\ T^{-1}$	10^{-23}	$erg\ G^{-1}$ *
	μ_p/μ_N	2.79276	7	10^{0}	....	10^{0}	
(uncorrected for diamagnetism, H_2O)	μ'_p/μ_N	2.79268	7	10^{0}	....	10^{0}	
Anomalous electron moment corrn.	$(\mu_e/\mu_0)-1$	1.159615	15	10^{-3}	....	10^{-3}	
Zeeman splitting constant	μ_B/hc	4.66858	4	10^{1}	$m^{-1}T^{-1}$	10^{-5}	$cm^{-1}G^{-1}$ *
Gas constant	R	8.3143	12	10^{0}	$J\ {}^\circ K^{-1}\ mol^{-1}$	10^{7}	$erg\ {}^\circ K^{-1}\ mol^{-1}$
Normal volume perfect gas	V_0	2.24136	30	10^{-2}	$m^3\ mol^{-1}$	10^{4}	$cm^3\ mol^{-1}$
Boltzmann constant	k	1.38054	18	10^{-23}	$J\ {}^\circ K^{-1}$	10^{-16}	$erg\ {}^\circ K^{-1}$
First radiation constant ($2\pi hc^2$)	c_1	3.7415	3	10^{-16}	$W\ m^2$	10^{-5}	$erg\ cm^2\ s^{-1}$
Second radiation constant	c_2	1.43879	19	10^{-2}	$m\ {}^\circ K$	10^{0}	$cm\ {}^\circ K$
Wien displacement constant	b	2.8978	4	10^{-3}	$m\ {}^\circ K$	10^{-1}	$cm\ {}^\circ K$
Stefan-Boltzmann constant	σ	5.6697	29	10^{-8}	$W\ m^{-2}\ {}^\circ K^{-4}$	10^{-5}	$erg\ cm^{-2}\ s^{-1}\ {}^\circ K^{-4}$
Gravitational constant	G	6.670	15	10^{-11}	$N\ m^2\ kg^{-2}$	10^{-8}	$dyn\ cm^2\ g^{-2}$

‡ Based on 3 std. dev.; applied to last digits in preceding column.
* Electromagnetic system.
† Electrostatic system.
C—coulomb J—joule Hz—hertz W—watt N—newton T—tesla G—gauss

TABLE X.—ENERGY CONVERSION FACTORS (RECOMMENDED BY NAS-NRC, 1963)

	Formula	Factor	Error limit	Conversion			
				Système International (MKSA)		Centimeter-gram-second (CGS)	
Electron-volt	eV	1.60210	7	$\times 10^{-19}$	$J(eV)^{-1}$	$\times 10^{-12}$	$erg\ (eV)^{-1}$
Energy associated with							
Unified atomic mass unit	c^2/Ne	9.31478	15	10^8	$eV\ u^{-1}$	10^8	$eV\ u^{-1}$
Proton mass	m_pc^2/e	9.38256	15	10^8	$eV\ m_p^{-1}$	10^8	$eV\ m_p^{-1}$
Neutron mass	m_nc^2/e	9.39550	15	10^8	$eV\ m_n^{-1}$	10^8	$eV\ m_n^{-1}$
Electron mass	m_ec^2/e	5.11006	5	10^5	$eV\ m_e^{-1}$	10^5	$eV\ m_e^{-1}$
Cycle	e/h	2.41804	7	10^{14}	$Hz(eV)^{-1}$	10^{14}	$s^{-1}(eV)^{-1}$
Wavelength	ch/e	1.23981	4	10^{-6}	$eV\ m$	10^{-4}	$eV\ cm$
Wave number	e/ch	8.06573	23	10^5	$m^{-1}(eV)^{-1}$	10^3	$cm^{-1}(eV)^{-1}$
°K	e/k	1.16049	16	10^4	$°K(eV)^{-1}$	10^4	$°K(eV)^{-1}$

physical double star. Two stars in nearly the same line of sight and at approximately the same distance from the observer, as distinguished from an optical double star (two stars in nearly the same line of sight but differing greatly in distance from the observer).

If the stars revolve about their common center of mass, they are called a *binary star.*

physical equation = equation of piezotropy.

physical meteorology. That branch of meteorology which deals with optical, electrical, acoustical, and thermodynamic phenomena of atmospheres, their chemical composition, the laws of radiation, and the explanation of clouds and precipitation. As generally accepted, it does not include mathematical theory of the motions of the atmosphere and the forces responsible therefore (which matters fall in the field of **dynamic meteorology**). Also called *atmospheric physics.*

Subdivisions of physical meteorology include **atmospheric electricity, cloud physics, precipitation physics, atmospheric acoustics,** and **atmospheric optics.**

physical system = cgs system.

physiological acceleration. The **acceleration** experienced by a human or an animal test subject in an accelerating vehicle. See table XI.

Several different terminologies have been used to describe physiological acceleration. Since the terminology may be based either on the action of the acclerating vehicle or the reaction of the passenger, the terms used are often confusing to a reader without prior knowledge of the system of terminology used.

Probably the most easily understood system is the *eyeballs in, eyeballs out, eyeballs down, eyeballs up,* etc., terminology used by test pilots, which refers to the sensations experienced by the person being accelerated. Thus, the acceleration experienced in an aircraft pullout or inside loop is *eyeballs down.* Note that, in the NASA vehicle (center of gravity displacement) terminology, this is $-a_z$ acceleration.

Some physiological-acceleration terminologies designate accelerations in terms of the equivalent displacement acceleration of the subject as if he were starting from rest. In such terminologies a man standing up or sitting down on the surface of the earth is experiencing 1 g of *headward* acceleration because of gravity. Other descriptive terms used in this way are *footward, forward* (the acceleration experienced by a man pressed into the seat back by an accelerating vehicle), *rearward, leftward, rightward, spineward, sternumward,* and *tailward.* One terminology based on reaction uses the terms *head-to-foot* (the acceleration generated by a pullout in an aircraft), *chest-to-back, foot-to-head,* and *back-to-chest.*

physiology. The science that treats of the functions of living organisms or their parts, as distinguished from morphology, anatomy, etc.

phytotron. A **biotron** designed especially for research on plant life.

Pic, Pict. International Astronomical Union abbreviations for *Pictor.* See **constellation.**

pickoff. A sensing device that responds to angular movement to create a signal or to effect some type of control, as *a pickoff on a gyro in an automatic pilot.*

A pickoff may be a potentiometer, a photoelectric device, a kind of valve controlling the fluid flows and pressures in a system, or one of various other devices.

pickup. 1. A device that converts a sound, scene, or other form of intelligence into corresponding electric **signals** (e.g., a microphone, a television camera, or a phonograph pickup). **2.** The minimum current, voltage, power, or other value at which a **relay** will complete its intended function. **3. Interference** from a nearby circuit or electrical system.

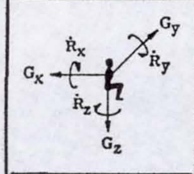
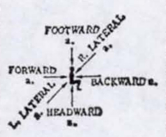
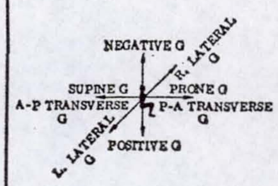
pico. A prefix meaning multiplied by 10^{-12}.

Pict. International Astronomical Union abbreviation for *Pictor.* See **constellation.**

Pictor (*abbr* **Pic, Pict**). See **constellation.**

piezoelectricity. The property exhibited by some asymmetrical crystalline materials which when subjected to strain in suitable directions develop electric **polarization** proportional to the strain.

TABLE XI.—PHYSIOLOGICAL ACCELERATION SYSTEMS[a]

Verbal definition [1]	Pictorial description [2]	Descriptive terms [3]	Vernacular description [4]	System 1:  AGARD symbols[b] [5]	System 1: Heart displacement [6]	System 2  [7]	System 3[b, c]  [8]	System 4 [9]	System 5 [10]
Linear forces or accelerations									
A force applied to the posterior part of the trunk, *acting forward with respect to the subject* and perpendicular to the mean spine *produces a forward acceleration*		Forward acceleration or forward acting force	Eyeballs in	$+G_x$	Moves toward back	Forward acceleration	Transverse A–P G Supine G Chest to back G	Sternumward	Surge
A force applied to the anterior part of the trunk, *acting backward with respect to the subject* and perpendicular to the mean spine *produces a backward acceleration*		Backward acceleration or backward acting force	Eyeballs out	$-G_x$	Moves toward front	Backward acceleration	Transverse P–A G Prone G Back to chest G	Spineward	—
A force applied to the left surface of the subject's body, *acting in a rightward direction* and essentially perpendicular to the subject's mean spine *produces a rightward acceleration*		Rightward acceleration or rightward acting force	Eyeballs left	$+G_y$	Moves toward left	Right lateral acceleration	Left lateral G	—	Left sway
A force applied to the right surface of the subject's body, *acting in a leftward direction* and essentially perpendicular to the subject's mean spine *produces a leftward acceleration*		Leftward acceleration or leftward acting force	Eyeballs right	$-G_y$	Moves toward right	Left lateral acceleration	Right lateral G	—	Right sway
A force applied to the buttocks, thighs, and/or feet, *acting in a headward direction with respect to the subject* and essentially parallel to the subject's mean spine *produces a headward acceleration*		Headward acceleration or headward acting force	Eyeballs down	$+G_z$	Moves toward feet	Headward acceleration	Positive G	Tailward	—
A force applied to the shoulders, thighs, and feet of a seated human *acting in a tailward direction with respect to the subject* and essentially parallel to the subject's mean spine produces a *tailward acceleration*		Tailward acceleration or tailward acting force	Eyeballs up	$-G_z$	Moves toward head	Footward acceleration	Negative G	Headward	Heave
Oscillatory forces or acceleration									
Forces that alternate in direction and produce alternately forward and backward motion of the subject, and that act essentially perpendicular to the spine, produce *front to back acceleration*		Front-to-back oscillating force or acceleration	—	$\pm G_x$	*Oscillates fore-and-aft within thorax*	—	—	—	—
Forces that alternate in direction and produce alternately side to side motion of the subject, and that act essentially perpendicular to the spine, produce *side to side acceleration*		Side-to-side oscillating force or acceleration	—	$\pm G_y$	Oscillates side-to-side within thorax	—	—	—	—
Forces that alternate in direction and produce alternately head to tail motion of the subject, and that act essentially parallel to the spine, produce *head to tail acceleration*		Head-to-tail oscillating force or acceleration	—	$\pm G_z$	Oscillates head-to-tail within thorax	—	—	—	—
Angular moments or acceleration									
A rotational moment or couple that produces a *head left motion* of the subject that lies essentially in the frontal (shoulder-to-shoulder) plane produces a *head left cartwheeling* angular acceleration		Head left cartwheeling moment or acceleration	—	$-R_x$	Top tilts toward right shoulder	—	—	—	—
A rotational moment or couple that produces a *head right motion* of the subject that lies essentially in the frontal (shoulder-to-shoulder) plane produces a *head right cartwheeling* angular acceleration		Head right cartwheeling moment or acceleration	—	$+R_x$	Top tilts toward left shoulder	—	—	—	—
A rotational moment or couple that produces a *head-forward feet backward* tumbling motion of the subject that lies essentially in the saggital plane produces a *forward somersaulting* angular acceleration		Forward somersaulting moment or acceleration	—	$-R_y$	Top tilts toward spine	—	—	—	—
A rotational moment or couple that produces a *head-backward feet-forward* tumbling motion of the subject that lies essentially in the saggital plane produces a *backward somersaulting* angular acceleration		Backward somersaulting moment or acceleration	—	$+R_y$	Top tilts toward sternum	—	—	—	—
A rotational moment or couple that produces a *right-turn motion* of the subject about the spine in the saggital plane produces a *right twisting* angular acceleration and will be named a *right turn pirouetting force or couple*		Right twisting moment or acceleration	—	$+R_z$	Twists toward subject's left	—	—	—	—
A rotational moment or couple that produces a *left-turn motion* of the subject about the spine in the saggital plane produces a *left twisting* angular acceleration		Left twisting moment or acceleration	—	$-R_z$	Twists toward subject's right	—	—	—	—

[a] The forces and accelerations to which vehicle occupants may be exposed are defined in column 1 and pictured in column 2. The descriptive terms to be used in discussions are tabulated in column 3 and the "eyeballs" vernacular terms are listed in column 4. The symbols previously recommended by AGARD and now to be associated with the terms in column 3 are listed in column 5. The reaction and motion of the heart *with respect to the subject's body* are listed in column 6. Previously used terminologies are listed in columns 7–10.

[b] Capital G is used as a unit to express inertial resultant to whole body acceleration in multiples of the magnitude of the acceleration of gravity, g_0 = 980.665 cm/sec^2 = 32.1739 ft/sec^2.

[c] A–P: anterior-posterior P–A: posterior-anterior.

Inverse piezoelectricity is the effect in which mechanical strain is produced in certain asymmetrical crystalline materials when subjected to an external electric field; the strain is proportional to the electric field.

piezoelectric transducer. A **transducer** utilizing a **piezoelectric** element.

pig discharge. See **Penning discharge,** note.

pile = nuclear reactor.

The term *pile* comes from the first nuclear reactor, which was made by piling up graphite blocks and pieces of uranium and uranium oxide. The term *reactor* is now more commonly used.

pillbox antenna. A cylindrical **parabolic reflector** enclosed by two plates perpendicular to the cylinder, so spaced as to permit the propagation of only one mode in the desired direction of **polarization.**

pilot. 1. A person who handles the **controls** of an aircraft or spacecraft from within the craft, and in so doing, guides or controls it in three-dimensional flight. **2.** A mechanical system designed to exercise **control** functions in an aircraft or spacecraft. **3.** To operate, control, or guide an aircraft or spacecraft from within the vehicle so as to move in three-dimensional flight through the air or space.

piloted. Of an aircraft or spacecraft, under, or subject to, continuous **control** by a person inside the vehicle.

This term is more specific than the term *manned.*

pinch effect. 1. The result of an electromechanical force that constricts, and sometimes momentarily ruptures, a molten **conductor** carrying current at high density. **2.** The self-contraction of a **plasma** column carrying large currents due to the interaction of this current with its own magnetic field.

The current required for such an effect is the order of 10^5 amperes. If the current is pulsed on for a short time, a radially imploding shock wave is generated.

P-indicator = plan position indicator (PPI).

pip. Signal indication on the **oscilloscope** screen of an electronic instrument, produced by a short, sharply peaked pulse of voltage. Also called **blip.**

Pirani gage. A **thermal-conductivity vacuum gage** in which an increase of pressure from the zero point causes a decrease in the temperature of a heated filament of material having a large temperature coefficient of resistance, thus unbalancing a Wheatstone bridge circuit (or the circuit is adjusted to maintain the filament temperature constant).

Pisc. International Astronomical Union abbreviation for *Pisces.* See **constellation.**

Pisces (*abbr* **Psc, Pisc**). See **constellation.**

Piscis Australis = Piscis Austrinus.

Piscis Austrinus (*abbr* **PsA, Psc A**). See **constellation.**

pitch. 1. Of a vehicle, an angular displacement about an axis parallel to the **lateral axis** of the vehicle. **2.** In **acoustics,** that attribute of auditory sensation in terms of which sounds may be ordered on a scale extending from low to high.

Pitch depends primarily upon the frequency of the sound stimulus, but it also depends upon the sound pressure and waveform of the stimulus.

The pitch of a sound may be described by the frequency or frequency level of that simple tone having a specified sound pressure level which is judged by listeners to produce the same pitch.

pitch attitude. The **attitude** of an aircraft, rocket, etc., referred to the relationship between the longitudinal **body axis** and a chosen reference line or plane as seen from the side.

pitch axis. A lateral axis through an aircraft, missile, or similar body, about which the body pitches. It may be a *body, wind,* or *stability* axis. Also called a *pitching axis.* See **axis,** sense **2** and note.

pitching axis = pitch axis.

pitching moment. A **moment** about a **lateral axis** of an aircraft, rocket, airfoil, etc.

This moment is positive when it tends to increase the angle of attack or to nose the body upward.

pitchover. 1. The programed turn from the **vertical** that a **rocket** takes as it describes an arc and points in a direction other than vertical. **2.** The point-in-space of this action.

pitot-static head = pitot-static tube.

pitot-static tube. A device consisting essentially of a unit combination of a **pitot tube** and a **static tube** arranged coaxially or otherwise parallel to one another, used principally in measuring **impact** and **static pressures;** also called **pitot-static head.**

The difference between impact and static pressures is used to measure the velocity of flow past the tube by means of a differential-pressure gage. The static pressure from a pitot-static tube may, in addition, be used in the operation of an altimeter and similar instruments.

pitot tube. (Pronounced pee-toe. After Henri Pitot, 1695–1771, French scientist.) An open-ended tube or tube arrangement which, when immersed in a moving **fluid** with its mouth pointed upstream, may be used to measure the **stagnation pressure** of the fluid for subsonic flow; or the stagnation pressure behind the tube's **normal shock wave** for supersonic flow.

plages. Clouds of calcium or hydrogen vapor that show up as bright patches on the surface of the **photosphere** of the sun.

Planck constant (*symbol* ***h***). A constant equal to 6.6256×10^{-27} erg second. It scales the energy of electromagnetic radiation of fre-

quency ν so that the radiation appears only in quanta $nh\nu$, n being an integer.

Planck distribution law = **Planck law.**

Planck law. An expression for the variation of monochromatic radiant flux per unit area of source as a function of wavelength of black-body radiation at a given temperature; it is the most fundamental of the **radiation laws.** Mathematically, Planck law is

$$dw = [c_1\lambda^{-5}/(e^{c_2/T\lambda} - 1)]\, d\lambda$$

where dw is the radiant flux from a black body in the wavelength interval $d\lambda$, centered around wavelength λ, per unit area of black-body surface at temperature T; c_1 and c_2 are **radiation constants.**

This law was derived theoretically by M. Planck in 1901.

plane polarized sound wave. At a point in an elastic medium, a **transverse wave** in which the displacements at all times lie in a fixed plane which is parallel to the direction of propagation. Also called *linearly polarized sound wave.*

The above definition is equivalent to stating that, in a plane polarized sound wave, the displacement vector at any point lies in a fixed straight line passing through the point.

planet. A **celestial body** of the **solar system,** revolving around the sun in a nearly circular orbit, or a similar body revolving around a star. See table XII. See also **astronomical constant,** tables II and III, noting that some values differ in the three tables.

The larger of such bodies are sometimes called *principal planets* to distinguish them from asteroids, planetoids, or minor planets, which are comparatively very small. The larger planets are accompanied by satellites, such as the moon. An inferior planet has an orbit smaller than that of the earth; a superior planet has an orbit larger than that of the earth. The four planets nearest the sun are called *inner planets*; the others, *outer planets.* The four largest planets are called *major planets.* The four planets commonly used for celestial observations are called *navigational planets.* The word *planet* is of Greek origin, meaning, literally, *wanderer*, applied because the planets appear to move relative to the stars.

planetary aberration. A displacement in the apparent position of a **planet** in the **celestial sphere** due to the relative movement of the observer and the planet. See **aberration.**

planetary boundary layer. That layer of the atmosphere from a planet's surface to the **geostrophic wind level** including, therefore, the **surface boundary layer** and the **Ekman layer.** Above this layer lies the **free atmosphere.** Also called *friction layer*, *atmospheric boundary layer.*

planetary circulation. **1.** The system of large-scale disturbances in a planet's **troposphere** when viewed on a hemispheric or world-wide scale. **2.** The mean or time-averaged hemispheric circulation of a planetary **atmosphere;** also called *general circulation.*

planetary configurations. Apparent positions of the **planets** relative to each other and to other bodies of the **solar system,** as seen from the earth.

planetary precession. That component of **general precession** caused by the effect of other **planets** on the equatorial protuberance of the earth, producing an eastward motion of the **equinoxes** along the **ecliptic.** See **precession of the equinoxes.**

Planetary precession is approximately 0.1247 second of arc per year.

planetocentric. **1.** Of or pertaining to a planet's center of mass. **2.** Of or pertaining to the **planet** as a center of a system.

planetographic. Referring to positions on a **planet** measured in **latitude** from the planet's **equator** and in **longitude** from a reference meridian.

planetoid = **asteroid.** See **planet.**

plane wave. A **wave** in which the **wave fronts** are everywhere parallel planes normal to the direction of **propagation.**

planform. The shape or form of an object, such as an *airfoil*, as seen from above, as in a *plan view.*

plan position indicator (*abbr* **PPI**). **1.** A **cathode-ray indicator** in which a **signal** appears on a radial line. Distance is indicated radially and bearing as an angle. **2.** In radar technique, a cathode-ray indicator on which **blips** produced by signals from reflecting objects and **transponders** are shown in plan position, thus forming a maplike display. Also called *P-indicator*, *P-scan*, *P-scope.*

A north-upward plan position indicator has north at the top of the indicator regardless of the heading; a heading-upward plan position indicator has the heading of the craft maintained at the top of the indicator. On a delayed plan position indicator the start of the sweep is delayed so that the center represents a selected range. This allows distant targets to be displayed on a short range scale, thus providing larger scale presentation. An open-center plan position indicator has no signal displayed within a set distance from the center. An off-center plan position indicator is one modified so that the center about which the trace rotates can be moved from the center of the screen to provide a larger scale for distant targets. A master plan position indicator controls remote indicators or repeaters.

plasma. An electrically conductive **gas** comprised of neutral particles, **ionized** particles, and **free electrons** but which, taken as a whole, is electrically neutral.

A plasma is further characterized by relatively large intermolecular distances, large amounts of energy stored in the internal energy levels of the particles, and the

TABLE XII.—PLANETS[a]
Mean elements of planetary orbits
(for epoch 1960 January 1.5 E.T.)

	Inclination i	Mean longitude of node Ω	Mean longitude of perihelion ϖ	Mean longitude at epoch L	Eccentricity e
	°	°	°	°	
Mercury	7.00399	47.85714	76.83309	222.62165	0.205627
Venus	3.39423	76.31972	131.00831	174.29431	0.006793
Earth	0.0	0.0	102.25253	100.15815	0.016726
Mars	1.84991	49.24903	335.32269	258.76729	0.093368
Jupiter	1.30536	100.04444	13.67823	259.83112	0.048435
Saturn	2.48991	113.30747	92.26447	280.67135	0.055682
Uranus	0.77306	73.79630	170.01083	141.30496	0.047209
Neptune	1.77375	131.33980	44.27395	216.94090	0.008575
Pluto[b]	17.1699	109.88562	224.16024	181.64632	0.250236

	Mean distance from Sun, AU	Mean distance from Sun, 10^6 km	Sidereal period (tropical years)	Synodic period	Mean daily motion n	Orbital velocity (km/sec)
				d	°	
Mercury	0.387099	57.9	0.24085	115.88	4.092339	47 8
Venus	0.723332	108.1	0.61521	583.92	1.602131	35.0
Earth	1.000000	149.5	1.00004		0.985609	29.8
Mars	1.523691	227.8	1.88089	779.94	0.524033	24.2
Jupiter	5.202803	778	11.86223	398.88	0.083091	13.1
Saturn	9.538843	1426	29.45772	378.09	0.033460	9.7
Uranus	19.181951	2868	84.01331	369.66	0.011732	6.8
Neptune	30.057779	4494	164.79345	367.48	0.005981	5.4
Pluto[b]	39.43871	5896	247.686	366.72	0.003979	4.7

Dimensions and rotations of the planets

	Semi-diameter at unit distance	Radius[c] on scale Earth	Reciprocal of flattening	Mass on scale Earth	Density, g/cm³	Surface gravity Earth	Rotation period	Inclination of Equator to orbit
	″	= 1		= 1		= 1		
Mercury	3.34	0.39	∞	0.056	5.13	0.36	88[d]	?
Venus	8.41	0.97	∞	0.817	4.97	0.87	?	32°
							h m s	° ′
Earth	8.80	1.00	2.9825[d]	1.000	5.52	1.00	23 56 04	23 27
Mars	4.68	0.53	192	0.108	3.94	0.38	24 37 23	23 59
Jupiter	98.47	11.19	16.1	318.0	1.33	2.64	9 50 30	3 04
Saturn	83.33	9.47	10.4	95.2	0.69	1.13	10 14	26 44
Uranus	34.28	3.69	16	14.6	1.56	1.07	10 49	97 53
Neptune	36.56	3.50	50	17.3	2.27	1.41	14 ?	28 48
Pluto	10 ?	1.1 ?	?	0.9 ?	4 ?	?	6[d].39 ?	?

[a] From the *Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac, 1961.*
[b] The elements for Pluto are osculating values for epoch 1960 September 23.0 E.T. = J.D. 2,437,200.5.
[c] The radii of the planets are based on recent values for the angular semi-diameters; the equatorial radius of the earth is 6,378 km = 3,963 miles.
[d] Adopted by IAU, 1963.

presence of a **plasma sheath** at all boundaries of the plasma.

Plasmas are sometimes referred to as a fourth state of matter.

plasma cloud Specifically, a mass of **ionized** gas flowing out of the sun.

plasma engine. A **reaction engine** using magnetically accelerated **plasma** as **propellant.**

A plasma engine is a type of electrical engine.

plasma frequency. The **natural frequency** for motion of **electrons** in a **plasma.** The plasma frequency

$$f = \sqrt{Ne^2/\pi m}$$

where e is charge on the electron; m is mass of the electron; and N is number of electrons per cubic centimeter. See **critical frequency.**

plasma generator. **1.** A machine, such as an electric-arc chamber, that will generate very

Plasma etching - see radio frequency plasma etching

high heat fluxes to convert neutral gases into **plasma.** **2.** A device which uses the interaction of a plasma and electrical field to generate a current.

plasma length = **Debye length.**

plasma physics. The study of the properties of **plasmas.**

plasma rocket. A rocket using a **plasma engine.** Also called *electromagnetic rocket.*

plasma sheath. **1.** The boundary layer of charged particles between a **plasma** and its surrounding walls, electrodes, or other plasmas.

The sheath is generated by the interaction of the plasma with the boundary material. Current flow may be in only one direction across the sheath (single sheath), in both directions across the sheath (double sheath), or when the plasma is immersed in a magnetic field, it may flow along the sheath surface at right angles to the magnetic field (magnetic current sheath).

2. An envelope of **ionized** gas that surrounds a body moving through an atmosphere at **hypersonic** velocities.

The plasma sheath affects transmission, reception, and diffraction of radio waves; thus it is important in operational problems of spacecraft.

plasticity. The tendency of a loaded body to assume a deformed state other than its original state when the load is removed.

plate. **1.** A planar body whose thickness is small compared with its other dimensions. **2.** A common name for the principal **anode** in an **electron tube.**

Platonic year = **great year.**

plus count. In the **launch** of a **rocket,** a count in seconds (plus 1, plus 2, etc.) that immediately follows **T-time,** used to check on the sequence of events after the action of the **countdown** has ended.

#PLUMBICON - TV CAMERA PICKUP TUBE see 70N36739

Pluto. See **planet,** table.

PM (*abbr*) = **phase modulation.**

PMR (*abbr*) = ***P*acific *M*issile *R*ange.**

pneumatic-probe pyrometer. A **thermometer** for high-temperature gases, in which the gas is sucked through a nozzle and then cooled. Reliance is placed principally on knowledge of the law of gas expansion through the nozzle and on measurement of pressure and mass flow rate of the gas.

pod. An enclosure, housing, or detachable container of some kind, as an *engine pod.*

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point discharge. A silent, nonluminous, **gaseous electrical discharge** from a pointed conductor maintained at a potential which differs from that of the surrounding gas. Compare **corona discharge, spark discharge.**

point of inflection. See **inflection.**

poise. The unit of viscosity in the cgs system equal to 1 dyne second per square centimeter.

Poiseuille flow. The steady laminar flow of a **fluid** through a narrow horizontal circular cylinder according to the relation

$$u = (1/4\mu)\ (\partial p/\partial x)\ (a^2 - r^2)$$

where u is the fluid velocity along the cylinder's axis at a distance r from the cylinder's axis; μ is the dynamic viscosity of the fluid; a is the cylinder radius; and $\partial p/\partial x$ is the pressure gradient along the axis of the cylinder. The velocity profile across the cylinder is seen to be parabolic, and this relation affords a convenient experimental means of determining a fluid's viscosity. Also called *Hagen-Poiseuille flow.* Compare **Couette flow.**

poison. In a nuclear reactor, those atoms (of such elements as boron) other than **fuel** that have large capture **cross sections** for **thermal neutrons.** In capturing thermal neutrons unproductively, these atoms decrease the number available to cause fission.

Poisson constant (*symbol* μ). The ratio of the **gas constant** to the **specific heat** of a gas at constant pressure.
See **Poisson equation,** sense **2.**

Poisson distribution. A one-parameter discrete frequency distribution giving the probability that n points (or events) will be (or occur) in an interval (or time) x, provided that these points are individually independent and that the number occurring in a subinterval does not influence the number occurring in any other nonoverlapping subinterval. It has the form

$$f(n,x) = e^{-\sigma x}(\sigma x)^n/n!$$

The mean and variance are both σx, and σ is the average density (or rate) with which the events occur. When σx is large, the Poisson distribution approaches the normal distribution. The binomial distribution approaches the Poisson when the number of events n becomes large and the probability of success P becomes small in such a way that $nP \longrightarrow \sigma x$.

Poisson equation. **1.** The partial differential equation

$$\nabla^2\varphi = F$$

where ∇^2 is the Laplacian operator; φ is a scalar function of position; and F is a given function of the independent space variables. For the special case $F = 0$, the Poisson equation reduces to the Laplace equation. See **relaxation method.** **2.** The relationship between the temperature T and pressure p of a perfect gas undergoing an **adiabatic** process; given by

* Pogo pulsing - intentional introduction of pressure pulses into feedlines to test propulsion system's ability to damp out oscillations which might occur in flight as a result of interaction of propellants, structural vibration modes + vehicle flight acceleration.
— NASA News Release 81-16

$$T = \text{constant} \times p^{\mu}$$

where μ is the **Poisson constant.**

This equation defines a family of process lines, called *isentropes* or *dry adiabats*, each of which represents the changes of state possible in a fluid with a constant value of **entropy.**

polar blackout = **blackout.**

polar coordinates. **1.** In a plane, a system of **curvilinear coordinates** in which a point is located by its distance r from the origin (or pole) and by the angle θ which a line (radius vector) joining the given point and the origin makes with a fixed reference line, called the polar axis. The relations between rectangular Cartesian coordinates and polar coordinates are

$$x = r\cos\theta,\ y = r\sin\theta,\ r^2 = x^2 + y^2$$

where the origins of the two systems coincide and the polar axis coincides with the X-axis. **2.** In three dimensions, short for **space polar coordinates.**

polar distance. Angular distance from a **celestial pole;** the arc of an **hour circle** between a celestial pole, usually the elevated pole, and a point on the **celestial sphere,** measured from the celestial pole through 180°.

If the declination, d, and the celestial pole are of the same name, the polar distance is $90° - d$, but if of contrary name, it is $90° + d$. See **codeclination.**

polarimeter. An instrument for determining the degree of **polarization** of **electromagnetic radiation,** specifically the polarization of light.

polariscope. An instrument for detecting **polarized** radiation and investigating its properties.

polarity. The sign of the electric discharge associated with a given object, as an **electrode** or an **ion.**

polarizability. A measure of the degree to which any given **atom** or **ion** undergoes **polarization** in the presence of an external electric field.

polarization. **1.** The state of **electromagnetic radiation** when transverse vibrations take place in some regular manner, e.g., all in one plane, in a circle, in an ellipse, or in some other definite curve.

Radiation may become polarized because of the nature of its emitting source, as is the case with many types of radar antennas, or because of some processes to which it is subjected after leaving its source, as that which results from the scattering of solar radiation as it passes through the earth's atmosphere.

2. With respect to particles in an **electric field,** the displacement of the charge centers within a particle in response to the electric force acting thereon. See **polarizability.** **3.** The response of the molecules of a **paramagnetic** medium (such as iron) when subjected to a **magnetic field.**

A right-handed polarized wave is defined as one receding from the observer and radiated by en electric vector rotating clockwise in a fixed plane that is in front of the observer and at right angles to the direction of propagation of the wave in question. Left-handed polarization is the rotation in a counter-clockwise manner.

This recommended definition of circular (or elliptical) polarization sense is according to that of the Institute of Radio Engineers. The definition of classical physics is exactly the opposite.

polarizer. A device for **polarizing** radiant energy. See **polarization.**

polar orbit. The **orbit** of an earth **satellite** that passes over or near the earth's poles.

Polar Year. See **International Polar Year.**

pole. **1.** The origin of a system of **polar coordinates.** **2.** For any circle on the surface of a sphere, the point of intersection of the surface of the sphere and the normal line through the center of the circle. See **geographical pole, celestial pole, elevated pole, depressed pole, ecliptic pole, fictitious pole.** **3.** A point of concentration of electric charge. See **dipole.** **4.** A point of concentration of magnetic force. See **magnetic pole.**

pole of the Milky Way. The **pole** in the **galactic system of coordinates.**

polytropic atmosphere. A **model atmosphere** in **hydrostatic equilibrium** with a constant nonzero lapse rate. The vertical distribution of pressure and temperature is given by

$$p/p_0 = (T/T_0)^{g/R\gamma}$$

where p is the pressure; T is the Kelvin temperature; g is the acceleration of gravity; R is the gas constant for the gases concerned; and γ is the environmental lapse rate. The subscript 0 denotes values at the planet's surface.

polytropic process. A **thermodynamic** process in which changes of pressure p and density ρ are related according to the formula

$$p\rho^{-\lambda} = p_O\rho_O{}^{-\lambda}$$

where λ is a constant and the subscript *0* denotes initial values of the variables. Therefore pressure and temperature are similarly related:

$$p/p_O = (T/T_O)^k$$

where k is the coefficient of polytropy. For isobaric processes, $k = 0$; for isosteric processes, $k = 1$; for adiabatic processes $k = c_p/R$, where c_p is the specific heat at constant pressure and R is the gas constant.

In meteorology this formula is applied to individual

gas parcels and should be distinguished from that for a polytropic atmosphere, which describes a distribution of pressure and temperature in space. See **equation of piezotropy.**

population. In statistical usage, any definite class of individuals or objects. Also called *universe.* Compare **sample.**

port. **1.** A place of access to a **system** where **energy** may be supplied or withdrawn or where system variables may be observed or measured.

In any particular case, the ports are determined by the way in which the system is used, and not by the structure alone.

A designated pair of terminals is an example of a port

2. An opening, as the *port* in a solid rocket.

posigrade rocket. An auxiliary **rocket** which fires in the direction in which the **vehicle** is pointed, used, for example, in separating two stages of a vehicle.

position. **1.** A point in space. **2.** A point defined by stated or implied **coordinates,** particularly one on the surface of the earth. **3.** = **attitude.** **4.** A crew member's station aboard an aircraft or spacecraft. See **line of position, band of position, surface of position.**

positional notation. Any scheme for representing quantities characterized by the arrangement of **digits** in sequence with the understanding that successive digits are to be interpreted as coefficients of successive **powers** of an integer called the **base** or radix.

The base determines the name of the notation, as, *binary* (base 2), *decimal* (base 10), or *duodecimal* (base 12).

position angle = **parallactic angle.**

position vector. See **vector.**

positive acceleration. **1.** Acceleration such that speed increases. **2.** Accelerating force in an upward sense or direction, e.g., from bottom to top, seat to head, etc.; acceleration in the direction that this force is applied. See **physiological acceleration.**

positive feedback. **Feedback** which results in increasing the amplification.

positive g or **positive G.** See **physiological acceleration.**

positron. A **subatomic particle** which is identical to the **electron** in atomic mass, theoretical rest mass, and energy, but opposite in sign. Compare **proton.**

The positron is short lived and can exist only when in motion. When it combines with an electron, both particles are annihilated and two photons result, equal in energy to the combined masses of the annihilated particles. Production of positrons can occur only in **pair formation** with the electron, the inverse of the **annihilation** process.

posthypoxia paradox. An abrupt convulsive incident which may occur when a marked oxygen deficiency is relieved by sufficient oxygen; this is in contrast to the normal rapid recovery from lack of oxygen. Also called *oxygen paradox.*

potential (*symbol* ϕ). **1.** A function of space, the **gradient** of which is equal to a **force.** In symbols, $F = -\nabla\phi$, where F is the force; ∇ is the del-operator; and ϕ is the potential. A force which may be so expressed is said to be *conservative*, and the work done against it in motion from one given equipotential surface to another is independent of the path of the motion. See **Gibbs function, potential energy.**

In *celestial mechanics* and *geodesy*, the negative of the potential, sometimes called *force function*, is usually employed.

2. Applied to the value that an atmospheric thermodynamic variable would attain if processed adiabatically from its initial pressure to the standard pressure of 1000 millibars. See **potential density, potential temperature.** **3.** Short for **electric potential.**

potential density. The density a parcel of air would attain if compressed adiabatically by descent to the standard pressure of 1000 millibars. The potential density ρ' is most easily defined in relation to the **potential temperature** θ as

$$\rho' = p/R\theta$$

where p is a pressure of 1000 millibars and R is the gas constant, in appropriate units. See **adiabatic process.**

potential energy. **Energy** possessed by a body by virtue of its position in a **gravity** field in contrast with **kinetic energy,** that possessed by virtue of its motion.

potential gradient. In general, the local space rate of change of any **potential,** as the *gravitational potential gradient* or the *velocity potential gradient.*

potential index of refraction. An atmospheric **index of refraction** so formulated that it would have no height variation in an **adiabatic atmosphere.** Also called *potential refractive index.* Compare **modified index of refraction.**

The potential index of refraction is usually expressed in terms of **B-units.**

potential refractive index = **potential index of refraction.**

potential temperature. The **temperature** a **parcel** of dry air would have if brought adiabatically from its initial state to the (arbitrarily selected) standard pressure of 1000

millibars. Its mathematical expression is

$$\theta = T(1000/p)^{R/c_p}$$

where θ is the potential temperature; T is the Kelvin temperature; p is pressure, millibars; R is the gas constant for dry air; and c_p is the specific heat of dry air at constant pressure. See **equivalent potential temperature, adiabatic process.**

potentiometer. **1.** An instrument for measuring differences in **electric potential** by balancing the unknown voltage against a variable known voltage. If the balancing is accomplished automatically, the instrument is called a *self-balancing potentiometer.* **2.** A variable electric resistor.

potentiometric transducer. A **transducer** in which the displacement of the force summing members is transmitted to the slider in a **potentiometer,** thus changing the ratio of output resistance to total resistance.

pound (*abbr* **lb**). **1.** A unit of mass equal in the United States to 0.45359237 kilogram, exactly. **2.** Specifically, a unit of measurement of the thrust or force of a reaction engine representing the weight the engine can move, as *an engine with 100,000 pounds of thrust.* See **poundal, pound mass.** **3.** The force exerted on 1 **pound mass** by the standard **acceleration of gravity.** See **gravity,** sense **2.**

poundal. A unit of force; that unbalanced force which, acting on a body of 1 pound mass, produces an **acceleration** of 1 foot per second squared. See **pound, pound mass.**

pound force = **pound,** sense 3.

pound mass. **1.** A **mass** equal to 0.45359237 kilogram. **2.** A unit of measure of the inertial property equal to the mass of a body weighing 1 pound at the standard acceleration of **gravity** (980.665 centimeters per second squared).

pound weight. A **force** equal to the earth's attraction for a mass of 1 pound. This force, acting on a **1-pound mass,** will produce an acceleration of 32.1747 feet per second squared.

power. **1.** (*symbol* ***P***). Rate of doing **work.** **2.** Luminous intensity. **3.** The number of times an object is magnified by an optical system, such as a telescope. Usually called *magnifying power.* **4.** The result of multiplying a number by itself a given number of times, as *the third power of a number is its cube;* the superscript which indicates this process as in $2^3 = 2 \times 2 \times 2$.

power density. The rated **power** of a **reactor** or isotopic power source per unit volume. Power density is often stated in kilowatts per cubic centimeter of core volume.

power gain. **1.** The ratio of the **power** that a **transducer** delivers to a specified **load,** under specified operating conditions, to the power absorbed by its input circuit.

If the input and/or output power consist of more than one component, such as multifrequency signal or noise, then the particular components used and their weighting must be specified.

This gain is usually expressed in decibels.

2. Of an antenna, in a given direction, 4π times the ratio of the radiation intensity in that direction to the total power delivered to the **antenna.**

power loading. The ratio of the gross weight of a propeller-driven **aircraft** to its power, usually expressed as the gross weight of the aircraft divided by the rated horsepower of the power plant corrected for air of standard density. With turboprop engines, the equivalent shaft horsepower is used. Compare **thrust loading.**

power package. An engine, especially a **reciprocating engine,** together with its accessories, lines, cowling, etc., ready for quick installation on an aircraft.

power plant. **1.** The complete assemblage or installation of **engine** or engines with accessories (induction system, cooling system, ignition system, etc.) that generates the motive power for a self-propelled vehicle or vessel such as an aircraft, rocket, etc. **2.** An engine or engine installation regarded as a source of **power.**

power series. An infinite series of increasing powers of the variable, of the form

$$\sum_{n=0}^{\infty} a_n x^n = a_0 + a_1 x + a_2 x^2 \ldots + a_n x_n$$

Both the variable and the coefficients may take on complex values. The totality of values of x for which a power series is convergent is called the *interval of convergence* of the series.

power spectrum. The square of the amplitude of the (complex) **Fourier coefficient** of a given periodic function. Thus if $f(t)$ is periodic with period T, its Fourier coefficients are

$$F(n) = 1/T \int_0^T f(t) e^{-in\omega t} dt$$

where $\omega = 2\pi/T$ and the power spectrum of $f(t)$ is $|F(n)|^2$. Here n takes integral values and the spectrum is discrete. The total energy of the periodic function is infinite, but the power, or energy per unit period, is finite.

Poynting-Robertson effect. The gradual decrease in **orbital velocity** of a small particle

such as a micrometeorite in orbit about the sun due to the **absorption** and reemission of **radiant energy** by the particle.

PPI (*abbr*) = **plan position indicator.**

PPI reflectoscope. See **beam splitter.**

PPI scope = **plan position indicator.**

PPM (*abbr*) =**pulse position modulation.**

PPM/AM (*abbr*). **Amplitude modulation** of **a carrier** by **pulses** which are position modulated by information.

Prandtl number (*symbol* N_{Pr}, P_r). (After Ludwig Prandtl, 1875–1953, German scientist.) A dimensionless number representing the ratio of **momentum transport** to **heat** transport in a flow, defined by the equation

$$N_{Pr} = \mu c_p/k$$

where μ is the viscosity coefficient; c_p is the specific heat at constant pressure; and k is the coefficient of thermal conductivity.

The Prandtl number may also be defined as the product of the **Reynolds** and **Péclet** numbers.

preamplifier. **1.** An **amplifier,** the primary function of which is to raise the output of a low-level **source** to an intermediate level so that the **signal** may be further processed without appreciable degradation in the signal-to-noise ratio of the system.

A preamplifier may include provision for equalizing and/or mixing.

2. In radar an amplifier separated from the remainder of the receiver and located so as to provide the shortest possible input circuit path from the antenna so as to avoid deterioration of the signal-to-noise ratio.

precession. Change in the direction of the axis of rotation of a spinning body, as a gyro, when acted upon by a **torque.** See **apparent wander, precession of the equinoxes.**

The direction of motion of the axis is such that it causes the direction of spin of the gyro to tend to coincide with that of the impressed torque. The horizontal component of precession is called *drift*, and the vertical component is called *topple*.

precession in declination. The component of **general precession** along a **celestial meridian,** amounting to about 20 seconds of arc per year.

precession in right ascension. The component of **general precession** along the **celestial equator,** amounting to about 46.1 seconds of arc per year.

precession of the equinoxes. The conical motion of the earth's **axis** about the normal to the plane of the **ecliptic,** caused by the attractive force of the sun, moon, and other planets on the equatorial protuberance of the earth.

The effect of the sun and moon, called *lunisolar precession*, is to produce a westward motion of the equinoxes along the ecliptic. The effect of other planets, called *planetary precession*, tends to produce a much smaller motion eastward along the ecliptic. The resultant motion, called *general precession*, is westward along the ecliptic at the rate of about 50.3 seconds of arc per year. The component of general precession along the celestial equator, called *precession in right ascension*, is about 46.1 seconds of arc per year; and the component along a celestial meridian, called *precession in declination*, is about 20.0 seconds of arc per year.

precipitation attenuation. The loss of radio **energy** due to the passage through a volume of the atmosphere containing precipitation. Part of the energy is lost by **scattering** and part by **absorption.** See **cloud attenuation, range attenuation.**

Radars operating at wavelengths of 10 centimeters and higher are generally unaffected, whereas even the smallest precipitation rates will seriously attenuate radar energy of wavelengths less than 1 centimeter. For rain and snow diameter-to-wavelength ratios less than 0.07, the loss is due primarily to absorption. Scattering becomes important for ratios near 0.1 and greater. Attenuation by dry snow is small for most radar wavelengths.

precision. The quality of being exactly or sharply defined or stated. A measure of the precision of a representation is the number of distinguishable alternatives from which it was selected, which is sometimes indicated by the number of **significant digits** it contains. Compare **accuracy.**

precombustion chamber. In a **rocket,** a chamber in which the **propellants** are ignited and from which the burning mixture expands torchlike to ignite the mixture in the main **combustion chamber.**

predissociation. A process by which a molecule that has absorbed energy separates into constituents before it loses energy by **radiation.** See **dissociation.**

preliminary stage = **prestage.**

presentation. In electronics, the act or process of displaying **radar** echoes on a cathode-ray screen; the **echo** or images displayed on a **cathode-ray screen.**

preset guidance. A type of **guidance** in which devices in the aircraft or spacecraft, adjusted before launching, **control** the path of the missile.

pressure (*symbol p*). **1.** In a gas, the net rate of transfer of momentum in the direction of the positive normal to an imaginary plane surface of specified area located in a specified position in the gas by molecules crossing the surface in both directions, momentum transmitted in the opposite direction being counted as negative, divided by the area of the surface.

In general, it is assumed that the area of the imaginary

plane surface is small enough so that the pressure with respect to any part of the surface is equal (within narrow limits) to the pressure based on the whole surface. Different kinds of pressure (static, dynamic, partial, total, vapor, etc.) are distinguished by the orientation of the surface with respect to mass-flow velocity vectors or by the restriction to a specified set of molecular species crossing the imaginary surface.

2. On a boundary surface, the force applied per unit area and equal to the pressure in the gas as determined by molecules crossing an imaginary surface located at a fixed distance of molecular magnitude in front of the real surface, the positive normal being drawn from the imaginary surface toward the real surface.

The term *pressure* when used alone can be assumed to refer to the total pressure in a gas at rest or else to refer to the static pressure in a gas flowing under steady-state conditions.

3. = **atmospheric pressure.** **4.** As measured in a vacuum system, the quantity measured at a specified time by a so-called **vacuum gage,** whose sensing element is located in a cavity (gage tube) with an opening oriented in a specified direction at a specified point within the system, assuming a specified calibration factor.

The sensitivity of the sensing element is, in general, not the same for all molecular species, but the gage reading is frequently reported using the calibration factor for air regardless of the composition of the gas. The opening to the gage tube is often carelessly oriented with respect to mass-flow vectors in the gas (which is seldom at rest), and errors due to variations in wall temperatures of tube and system are frequently neglected. The actual total pressure in a high-vacuum system cannot usually be measured by a single gage, but in vacuum technology the term *total pressure* is sometimes used to refer to the reading of a single untrapped gage which responds to condensable vapors as well as permanent gases.

pressure altimeter. An **altimeter** that utilizes the change of **atmospheric pressure** with height to measure **altitude.** It is commonly an aneroid altimeter. Also called *barometric altimeter.* See **aneroid,** sense **1.**

pressure altitude. **1.** Altitude in the earth's atmosphere above the standard datum plane, standard sea level pressure, measured by a pressure altimeter. **2.** The altitude in a standard atmosphere corresponding to atmospheric pressure encountered in a real atmosphere. **3.** The simulated altitude created in an altitude chamber.

pressure amplitude = **maximum sound pressure.**

pressure breathing. The breathing of oxygen or of a suitable mixture of gases at a **pressure** higher than the surrounding pressure. See **continuous pressure breathing, intermittent pressure breathing.**

pressure-breathing system. An oxygen system in which oxygen is injected inside the respiratory ducts through a pressure higher than the surrounding **pressure.**

pressure broadening. The process in which the width of the **lines** in an **emission spectrum** or **absorption spectrum** of a gaseous radiative medium is increased due to perturbations of the energy states by collisions of the molecules or atoms within the gas. The extent of this line-broadening effect is directly proportional to the number of impacts experienced by the emitter or absorber per unit time, and hence is proportional to the **pressure.** Compare **Doppler broadening.**

pressure-demand oxygen system. A **demand oxygen system** that furnishes oxygen at a **pressure** higher than atmospheric pressure above a certain altitude.

pressure height = **pressure altitude.**

pressure microphone. A **microphone** in which the electric output substantially corresponds to the instantaneous **sound pressure** of the impressed **sound wave.**

pressure stabilized. Referring to membrane-type structures that require internal pressure for maintenance of a stable structure; for example, the Atlas missile structure.

pressure suit. A garment designed to provide pressure upon the body so that respiratory and circulatory functions may continue normally, or nearly so, under low-pressure conditions, such as occur at high altitudes or in space without benefit of a **pressurized cabin.**

A pressure suit is distinguished from a pressurized suit, which inflates, although it may be fitted with inflating parts that tighten the garment as ambient pressure decreases. Compare **g-suit.**

pressure thrust. In rocketry, the product of the cross-sectional area of the exhaust **jet** leaving the **nozzle exit** and the difference between the **exhaust pressure** and the **ambient pressure.**

pressure transducer. A **transducer** which produces an output related to imparted pressure.

pressure wave. **1.** In meteorology, a short-period **oscillation** of **pressure** such as that associated with the propagation of **sound** through the atmosphere; a type of **longitudinal wave.** See **sound wave, compression wave.**

These waves are usually recorded on sensitive microbarographs capable of measuring pressure changes of amounts down to 10^{-4} millibar. Typical values for the period and wavelength of pressure waves are ½ to 5 seconds and 100 to 1500 meters, respectively.

Pressure waves produced by explosions in the upper atmosphere are of value in determining the high-altitude temperatures and winds.

2. A wave or periodicity which exists in the

variation of **atmospheric pressure** on any scale, usually excluding normal diurnal and seasonal trends. See **barometric wave.**

Such waves can persist for an indefinite length of time only if they coincide approximately with the free oscillations of the atmosphere. Waves of a period longer than that associated with the passage of large-scale weather disturbances are difficult to isolate, since they usually have such a small amplitude that they can be extracted from the data only by means of precise statistical methods.

pressurization. The process of producing **pressures** higher than ambient, as in a **pressurized cabin.**

pressurized. Containing air, or other gas, at a **pressure** higher than **ambient.**

pressurized suit. A suit designed to be inflated so as to provide pressure directly upon the body, not to air surrounding the body. Compare **pressure suit.**

pressurizing gas. Specifically, a gas used to expel propellant from a fuel tank.

prestage. **1.** A step in the action of igniting a large liquid rocket taken prior to the ignition of the full flow, and consisting of igniting a partial flow of **propellants** into the **thrust chamber.** **2.** The partial flow thus ignited. Also called *preliminary stage.*

primary. **1.** Short for **primary body.** **2.** Short for **primary cosmic ray.**

primary body. The **celestial body** or **central force field** about which a **satellite** or other body orbits, or from which it is escaping, or towards which it is falling.

The primary body of the moon is the earth; the primary body of the earth is the sun.

primary circle = primary great circle.

primary circulation. In meteorology, the prevailing fundamental atmospheric circulation on a planetary scale which must exist in response to radiation differences with latitude, to the rotation of the planet, and to the particular distribution of land and oceans; and which is required from the viewpoint of **conservation of energy.**

primary cosmic rays. High-energy **particles** originating outside the earth's **atmosphere.**

Primary cosmic rays appear to come from all directions in space. Their energy appears to range from 10^9 to more than 10^{17} electron volts.

primary great circle. A **great circle** used as the origin of measurement of a **coordinate;** particularly, such a circle 90° from the poles of a system of **spherical coordinates,** as the equator. Also called *primary circle, fundamental circle.*

primary radar. **Radar** using reflection only, in contrast with secondary radar which uses automatic retransmission on the same or a different radio frequency.

primary scattering. Any **scattering** process in which **radiation** is received at a detector, such as the eye, after having been scattered just once; to be distinguished from *multiple scattering.*

primary standard. A unit directly defined and established by some authority, against which all secondary standards are calibrated, as the prototype kilogram.

prime meridian. **1.** The **meridian** of longitude 0°, used as the origin for measurement of **longitude.** The meridian of Greenwich, England, is almost universally used for this purpose. **2.** Any meridian in any **coordinate system** used as an origin for measurement of longitude.

prime vertical. The **vertical circle** through the east and west points of the **horizon.** It may be *true, magnetic, compass,* or *grid* depending upon which east or west points are involved. Also called *prime vertical circle.*

prime vertical circle = prime vertical.

primitive atmosphere. The **atmosphere** of a **celestial body** as it existed in the early stages of its formation; specifically, the earth's atmosphere of 3 billion or more years ago, thought to consist of water vapor, carbon dioxide, methane, and ammonia gas.

primitive equations. The Eulerian **equations of motion** of a **fluid** in which the primary dependent variables are the fluid's velocity components. These equations govern a wide variety of fluid motions and form the basis of most hydrodynamical analysis.

primitive period. Of a **periodic quantity,** the smallest increment of the **independent variable** for which the function repeats itself.

If no ambiguity is likely, the primitive period is simply called the *period* of the function.

principal planets. The larger bodies revolving about the Sun in nearly circular orbits. See **planet.**

The known principal planets, in order of their distance from the Sun are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

principal stresses. The normal stresses on three mutually perpendicular planes on which there are no shear stresses.

principal vertical circle. The **vertical circle** through the north and south points of the **horizon,** coinciding with the **celestial meridian.**

principle of reciprocity. If an electromotive force at one point in a **circuit** produces a current at a second point in the circuit, then

the same voltage acting at the second point will produce the same current at the first point.

probable error (*symbol* e_p). In statistics, that value e_p for which there exists an even **probability** (0.5) that the actual error exceeds e_p. The probable error e_p is 0.6745 times the **standard deviation** σ.

The probable error is not 'probable' in the normal sense of the word.

probability. The chance that a prescribed event will occur, represented as a pure number P in the range $0 \leq P \leq 1$. The probability of an impossible event is zero and that of an inevitable event is unity.

Probability is estimated empirically by relative frequency, that is, the number of times the particular event occurs divided by the total count of all events in the class considered.

probability integral. The classical form (still widely used in engineering work) of the definite integral of the special **normal distribution** for which the **mean** $\mu = 0$ and **standard deviation** $\sigma = 1/\sqrt{2}$. Geometrically, the probability integral equals the area under this density curve between $-z$ and z, where z is an arbitrary positive number. Often denoted by the symbol *erf z* (read *error function of z*) the probability integral is defined thus:

$$erf\, z \equiv \frac{2}{\sqrt{\pi}} \int_0^z e^{-x^2} dx$$

Also called *error function*, *erf*.

probe. **1.** Any device inserted in an **environment** for the purpose of obtaining information about the environment. **2.** In geophysics, a device used to make a **sounding.** **3.** Specifically, an instrumented vehicle moving through the **upper atmosphere** or **space** or landing upon another celestial body in order to obtain information about the specific environment.

In sense **3**, almost any instrumented spacecraft can be considered a probe. However, earth satellites are not usually referred to as *probes*. Also, almost any instrumented rocket can be considered a probe. In practice, rockets which attain an altitude of less than 1 earth radius (4000 miles) are called *sounding rockets*, those which attain an altitude of *more* than 1 earth radius are called *probes* or *space probes*. Spacecraft which enter into orbit around the sun are called *deep-space probes*. Spacecraft designed to pass near or land on another celestial body are often designated *lunar probe*, *Martian probe*, *Venus probe*, etc.

4. Specifically, a slender device or apparatus projected into a moving **fluid,** as for measurement purposes; a **pitot tube.** **5.** Specifically, a slender projecting pipe on an aircraft which is thrust into a **drogue** to receive fuel in inflight refueling.

process lapse rate. The rate of decrease of the **temperature** T of an air **parcel** as it is lifted, $-dT/dz$, when z is altitude, or, occasionally, dT/dp, where p is pressure.

The concept may be applied to other atmospheric variables, e.g., the process lapse rate of density. The process lapse rate is determined by the character of the fluid processes and should be carefully distinguished from the environmental lapse rate, which is determined by the distribution of temperature in space. In the atmosphere the process lapse rate is usually assumed to be either the dry-adiabatic lapse rate or the saturation-adiabatic lapse rate.

profile. **1.** Of a **variable,** a curve representing corresponding values of two or more variables which may occur.

A profile accounts for the correlation from point to point on the curve and has some possibility, not necessarily specified, of actual occurrence.

2. The contour or form of a body, especially in a cross section; specifically, an airfoil profile. **3.** Something likened to a profile (sense **1**), such as a line on a graph, as *a flight profile.*

program. **1.** In **computer** operations, a plan for the solution of a problem. **2.** To create a plan for the solution of a problem.

A complete program includes plans for the transcription of data, coding for the computer, and plans for the absorption of the results into the system. The list of coded instructions, called a *routine*, plans a computation or process from the asking of a question to the delivery of the result, including the integration of the operation into an existing system. Thus, programing consists of planning and coding, including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system.

projectile. **1.** Any object, especially a **missile,** fired, thrown, launched, or otherwise projected in any manner, such as a bullet, a guided rocket missile, a sounding rocket, a pilotless airplane, etc. **2.** Originally, an object, such as a bullet or artillery shell, projected by an applied external force.

prolate spheroid. An **ellipsoid of revolution,** the longer **axis** of which is the axis of revolution.

An ellipsoid of revolution, the shorter axis of which is the axis of revolution, is called an *oblate spheroid*.

prominence. A filamentlike protuberance from the **chromosphere** of the sun. See **flocculi.** Compare **flare.**

Prominences can be observed visually (optically) whenever the sun's disk is masked, as during an eclipse or by using a **coronagraph**; and can be observed instrumentally by filtering in certain wavelengths, as with a **spectroheliograph.** A typical prominence is 6,000 to 12,000 kilometers thick, 60,000 kilometers high, and 200,000 kilometers long.

prompt neutrons. In nuclear **fission,** those **neutrons** released coincident with the fission process, as opposed to the neutrons subsequently released.

prompt radiation. See **radioactivity,** note.

propagation. The spreading abroad or sending forward, as of **radiant energy.**

propagation constant. Of a **traveling plane wave** at a given **frequency,** the complex quantity whose real part is the **attenuation constant** in nepers per unit length and whose imaginary part is the phase constant in radians per unit length.

propagation error. For **ranging systems,** the algebraic sum of **propagation velocity error** and **curved-path error.**

Except at long ranges and low angles, the curved-path component of propagation error is generally negligible.

propagation ratio. For a **wave** propagating from one point to another, the ratio of the complex **electric field strength** at the second point to that at the first point.

propagation velocity = **velocity of propagation.**

propagation-velocity error. The difference between the effective value of **propagation velocity,** over a ray path, and the assumed value. See **effective propagation velocity.**

propellant (*symbol* p, used as a subscript). Any agent used for consumption or combustion in a **rocket** and from which the rocket derives its thrust, such as a **fuel, oxidizer,** additive, catalyst, or any compound or mixture of these; specifically, a fuel, oxidant, or a combination or mixture of fuel and oxidant used in propelling a rocket. See **fuel.**

Propellants are commonly in either liquid or solid form.

propellant mass fraction (*symbol* ζ). Of a **rocket,** the ratio of the effective propellant mass m_p to the initial vehicle mass m_0 or

$$\zeta = m_p/m_0$$

Also called *mass ratio, propellant mass ratio.*

propellant mass ratio = **propellant mass fraction.**

proper motion. That component of the space motion of a **celestial body** perpendicular to the line of sight, resulting in the change of a star's **apparent position** relative to other stars. Proper motion is expressed in angular units.

proportional control. Control of an aircraft, rocket, etc. in which control-surface deflection is proportional to the movement of the remote **controls.** Compare **flicker control.**

proportional navigation. The **control** of the angular rate of the velocity vector of a vehicle in proportion to the apparent relative **angular velocity** of its moving target.

proprioceptive stimulation. Stimulation originating within the deeper structures of the body (muscles, tendons, joints, etc.) for sense of body position and movement and by which muscular movements can be adjusted with a great degree of accuracy and equilibrium can be maintained.

propulsive efficiency (*symbol* η_p). The efficiency with which energy available for propulsion is converted into thrust by a rocket engine.

$$\eta_p = (2u/c)/[1 + (u/c)^2]$$

where u is the absolute vehicle velocity, and c is the effective exhaust velocity with respect to the vehicle. Propulsive efficiency is a maximum when $u = c$.

proton. A positively charged **subatomic particle** having a mass of 1.67252×10^{-24} gram, slightly less than that of a neutron but about 1836 times greater than that of an electron.

proton-proton reaction. A **thermonuclear** reaction in which two **protons** collide at very high velocities and combine to form a **deuteron.** The resultant deuteron may capture another proton to form tritium and the latter may undergo proton capture to form helium. Compare **carbon cycle.**

The proton-proton reaction is now believed to be the principal source of energy within the sun and other stars of its class. A temperature of the order of 5 million degrees Kelvin and high hydrogen (proton) concentrations are required for this reaction to proceed at rates compatible with energy emission by such stars.

proton storm. The flux of **protons** sent into space by a **solar flare.**

protoplanet. Any of the sun's planets as it emerged or existed in the formative period of the **solar system.**

protosun. The sun as it emerged in the formation of the **solar system.**

prototype. 1. Of any mechanical device, a production model suitable for complete evaluation of mechanical and electrical form, design, and performance. **2.** The first of a series of similar devices. **3.** A physical standard to which replicas are compared, as *the prototype kilogram.*

proving stand. A test stand for **reaction engines,** especially rocket engines. See **test stand.**

PsA, Psc A. International Astronomical Union abbreviations for *Piscis Austrinus.* See **constellation.**

Psc, Pisc. International Astronomical Union abbreviations for *Pisces.* See **constellation.**

Psc A. International Astronomical Union abbreviation for *Piscis Austrinus.* See **constellation.**

pseudoadiabatic expansion. A saturation-adiabatic process in which the condensed water

substance is removed from the system, and therefore best treated by the thermodynamics of open systems. See **adiabatic process.**

Meteorologically, this process corresponds to rising air from which the moisture is precipitating. Descent of air so lifted becomes by definition a **dry-adiabatic process.**

pseudocode. An arbitrary code not directly understandable by a **computer.** Also called *interpreter code.*

pseudoequivalent temperature = equivalent temperature, sense 2.

pseudo-wet-bulb potential temperature = wet-bulb potential temperature.

psychology. The science which studies the functions of the mind, such as sensation, perception, memory, thought, and, more broadly, the behavior of an organism in relation to its environment.

psychomotor ability. Of or pertaining to muscular action ensuing directly from a mental process, as in the coordinated manipulation of aircraft or spacecraft controls.

psychophysical quantity. A physical measurement, as a **threshold,** dependent on human attributes or perception.

PTM (*abbr*) = ***pulse time modulation.***

pulmonary. Pertaining to, or affecting, the lungs or any component of the lungs.

pulse. 1. A variation of a quantity whose value is normally constant; this variation is characterized by a rise and a decay, and has a finite duration.

The word *pulse* normally refers to a variation in time; when the variation is in some other dimension, it should be so specified, such as *space pulse.*

This definition is so broad that it covers almost any transient phenomenon. The only features common to all pulses are rise, finite duration, and decay. It is necessary that the rise, duration, and decay be of a quantity that is constant (not necessarily zero) for some time before the pulse and has the same constant value for some time afterwards. The quantity has a normally constant value and is perturbed during the pulse. No relative time scale can be assigned.

2. Radar, sense **2. 3.** The intermittent change in the shape of an artery due to an increase in the tension of its walls following the contraction of the heart. The pulse is usually counted at the wrist (radial pulse), but may be taken over any artery that can be felt.

pulse amplitude. A general term indicating the **magnitude of a pulse.**

For specific designation, adjectives such as *average, instantaneous, peak, root-mean-square* (effective), etc., should be used to indicate the particular meaning intended.

Pulse amplitude is measured with respect to the normally constant value unless otherwise stated.

pulse amplitude modulation (*abbr* **PAM**). See **pulse modulation.**

pulse code. 1. A sequence of **pulses** so modulated as to represent information. **2.** Loosely, a **code** consisting of pulses, such as Morse code, **binary code.**

pulse code modulation (*abbr* **PCM**). Any modulation which involves a **pulse code.**

This is a generic term, and additional specification is required for a specific purpose.

pulsed Doppler system. A **pulse radar** system which utilizes the **Doppler effect** for obtaining information about the **target** (not including simple resolution from fixed targets).

pulse decay time. The interval between the instants at which the instantaneous amplitude of a pulse last reaches specified upper and lower limits, namely, 90 percent and 10 percent of the peak **pulse amplitude** unless otherwise stated.

pulsed radar = pulse radar.

pulse duration. The time interval between the first and last instants at which the instantaneous amplitude reaches a stated fraction of the peak **pulse amplitude.**

pulse duration modulation. A form of **pulse time modulation** in which the duration of a pulse is varied.

The terms *pulse width modulation* and *pulse length modulation* are also used to designate this system of modulation but the term *pulse duration modulation* is preferred.

pulse frequency modulation (*abbr* **PFM**). A form of **pulse time modulation** in which the **pulse repetition rate** is the characteristic varied.

A more precise term for *pulse frequency modulation* would be *pulse repetition-rate modulation.*

pulsejet. A **pulsejet engine.**

pulsejet engine. A type of compressorless **jet engine** in which combustion takes place intermittently, producing thrust by a series of explosions, commonly occurring at the approximate **resonance frequency** of the engine. Often called a *pulsejet.*

pulse length modulation = pulse duration modulation.

pulse modulation. 1. Modulation of a **carrier** by a **pulse train.** Compare **frequency modulation.**

In this sense, the term is used to describe the process of generating carrier frequency pulses.

2. Modulation of one or more characteristics of a **pulse carrier.**

In this sense, the term is used to describe methods of transmitting information on a pulse carrier.

pulse packet. In **radar,** the volume of space occupied by the radar **pulse** energy.

pulse phase modulation (*abbr* **PPM**) = **pulse position modulation.**

pulse position modulation (*abbr* **PPM**). A form of **pulse time modulation** in which the position in time of a **pulse** is varied. Also called *pulse phase modulation.*

pulse radar. A type of **radar,** designed to facilitate range measurement, in which the transmitted energy is emitted in periodic short **pulses.** Also called *pulsed radar.* Compare **continuous-wave radar.**

The distance to any target causing a detectable echo can be determined by measuring one-half the time interval between transmitted pulse and received echo and multiplying this number by the speed of light. This is by far the most common type of radar.

pulse repeater. In a **transponder,** a device used for receiving **pulses** from one circuit and transmitting corresponding pulses into another circuit. It may also change the frequency and wave forms of the pulses and perform other functions.

pulse spike. An unwanted **pulse** of relatively short duration superimposed on the main pulse.

pulse time modulation (*abbr* **PTM**). **Modulation** in which the values of instantaneous samples of the **modulating wave** are caused to modulate the time of occurrence of some characteristic of a **pulse carrier.**

pulse train. In radio, a sequence of **pulses.**

pulse width. The time interval during which a **pulse** exceeds a reference level.

For measuring pulse width, the reference level is generally taken at the **half power points.**

pulse width modulation (*abbr* **PWM**) = **pulse duration modulation.**

Pup, Pupp. International Astronomical Union abbreviations for *Puppis.* See **constellation.**

Puppis (*abbr* **Pup, Pupp**). See **constellation.**

purge. To rid a line or tank of residual fluid, especially of fuel or oxygen in the tanks or lines of a **rocket** after a test firing or simulated test firing.

Purkinje effect. The response of the human eye which makes it less sensitive to lights of longer wavelengths under conditions of decreased illumination, e.g., red appears darker at night than blue having the same brightness under photopic conditions. See **color index, dark adaptation, photopic vision.**

push-pull = **balanced.** See **balanced amplifier, balanced circuit.**

push-pull amplifier = **balanced amplifier.**

push-push circuit. A **circuit** employing two similar tubes with grids connected in **phase** opposition and plates in parallel to a common **load,** and usually used as a frequency multiplier to emphasize even-order harmonics.

PWM (*abbr*) = **pulse width modulation.**

pyranometer. An **actinometer** which measures the combined intensity of incoming **direct solar radiation** and **diffuse sky radiation.** The pyranometer consists of a recorder and a radiation sensing element which is mounted so that it views the entire sky. Sometimes called *solarimeter.* See **pyrheliometer, solarimeter, Robitzsch actinograph, albedometer.**

pyrgeometer. An actinometer which measures the **effective terrestrial radiation.** See **Ångström pyrgeometer.**

pyrheliometer. An actinometer which measures the intensity of **direct solar radiation,** consisting of a radiation sensing element enclosed in a casing which is closed except for a small aperture, through which the direct solar rays enter, and a recorder unit. See **Ångström compensation pyrheliometer, silver-disk pyrheliometer, water-flow pyrheliometer, Eppley pyrheliometer, spectropyrheliometer, Michaelson actinograph.**

pyrheliometry. The science and study of pyrheliometric measurements. See **pyrheliometer.**

pyrolysis. Chemical decomposition by the action of heat.

pyrometer. An instrument for the measurement of **temperatures;** generally applied to instruments measuring temperatures above 600° C.

pyrometric photography. The derivation of flame **temperature** measurements by means of comparative photography with a calibrated light source.

pyrometry. High-temperature **thermometry,** the technique of measurement of temperatures, generally above 600° C, at a distance.

pyron. A unit of radiant **intensity** of electromagnetic radiation equal to 1 calorie per square centimeter per minute.

pyrophoric fuel. A **fuel** that ignites spontaneously in air. Compare **hypergolic propellants.**

Pyx, Pyxi. International Astronomical Union abbreviations for *Pyxis* (=*Malus*). See **constellation.**

Pyxis (=**Malus**) (*abbr* **Pyx, Pyxi**). See **constellation.**

Q

q = dynamic pressure, as *the vehicle encountered maximum q 40 seconds after lift-off.*

Q-band. A **frequency band** used in **radar** extending approximately from 36 to 46 kilomegacycles. See **frequency band.**

quadrant. See **sextant.**

quadrature. **1.** An **elongation** of 90°, usually specified as *east* or *west* in accordance with the direction of the body from the sun. The moon is at quadrature at first and last quarters. Compare **conjunction. 2.** The situation of two **periodic quantities** differing by a quarter of a cycle.

quality factor (*symbol* Q). A measure of the sharpness of **resonance** or frequency selectivity of a resonant vibratory **system** having a single degree of freedom, either mechanical or electrical. See **vibration.**

In a mechanical system, this quantity is very nearly equal to one-half the reciprocal of the damping ratio. When used with reference to a lightly damped system, it is also approximately equal to the following: (1) transmissibility at resonance; (2) π/δ where δ is the logarithmic decrement; (3) $2\pi W/\Delta W$ where W is the stored energy and ΔW the energy dissipation per cycle; and (4) $f_r/\Delta f$ where f_r is the resonance frequency and Δf is the bandwidth between the half-power points.

Historically the letter Q was an arbitrarily chosen symbol to designate the ratio of reactance to resistance of a circuit element. The name *quality factor* was introduced later.

quanta. See **quantum theory.**

quantity. See **number.**

quantization. The process of converting from continuous values of information to a finite number of **discrete** values.

quantum theory. The theory first stated by Max Planck (before the Physical Society of Berlin on December 14, 1900) that all **electromagnetic radiation** is emitted and absorbed in *quanta*, each of magnitude $h\nu$, h being the **Planck constant** and ν the **frequency** of the radiation. See **radiation laws.**

quasi-geostrophic equilibrium. See **equivalent barotropic model.**

quasi-Lagrangian coordinates. A system of mixed **Eulerian** and **Lagrangian coordinates.** At least one coordinate of each **fluid parcel** must therefore be unvarying with time.

quiet sun. The sun when it is free from unusual radio wave or thermal **radiation** such as that associated with **sun spots.** See **IQSY.**

quintant. See **sextant.**

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R

rabbit. Video **display** of a beacon's replies to **interrogations** from two or more nonsynchronized **radars.**

racon. (From ***ra**dar bea**con**.*) A **transponder** for **interrogation** by a **primary radar.**

radar. (From ***ra**dio **d**etection **a**nd **r**anging.*) **1.** A method, system, or technique of using beamed, reflected, and timed **radio waves** for detecting, locating, or tracking objects (such as rockets), for measuring altitude, etc., in any of various activities, such as air traffic control or guidance. **2.** The electronic equipment or apparatus used to generate, transmit, receive, and, usually, to display radio scanning or locating waves; a radar set.

The terms *primary radar* and *secondary radar* may be used when the return signals are, respectively, by reflection and by the transmission of a second signal as a result of triggering responder **beacon** by the incident signal.

radar altimeter = radio altimeter.

radar altitude. The altitude of an aircraft or spacecraft as determined by a **radio altimeter;** thus, the actual distance from the nearest terrain feature.

radar astronomy. The study of celestial bodies within the solar system by means of **radiation** originating on earth but reflected from the body under observation. See **radio astronomy.**

radar band. See **frequency band.**

radar beacon. A **beacon** transmitting a characteristic signal on **radar** frequency, permitting a craft to determine the bearing and sometimes the range of the beacon.

A *racon* returns a coded signal when triggered by the proper type of radar pulse; a *ramark* continuously transmits a signal which appears as a radial line on the plan position indicator.

radar beam. See **beam.**

radar cross section. The ratio of **power** returned in a radar **echo** to power received by the **target** reflecting the signal. Compare **scattering cross section.**

radar duct. See **radio duct.**

radar echo. See **echo.**

radar frequency. See **frequency band.**

radar horizon. The **angle of elevation** at which the **beam** from a **radar** antenna is intercepted by the earth's horizon. Compare **radio horizon.**

radar indicator = radarscope.

radar mile. A time unit of 10.75 microseconds duration; the time it takes for the **signal** emitted by a **radar** to travel from the radar to a **target** one mile distant and return to the radar.

radar range. **1.** The distance from a **radar** to a target as measured by the radar. **2.** The maximum distance at which a radar set is effective in detecting targets.

Radar range depends upon variables such as weather conditions, type of target, etc. Radar range, sense **2**, is sometimes given a specific definition, e.g., the range at which the set is effective one-half of the time.

radar range equation. The relation between the maximum range R_{max} at which a point **target** is detectable and the properties of the **radar** and the target

$$R_{max} = [(PA^2\lambda^2\sigma)/(4\pi)^3S_{min})]^{\frac{1}{4}}$$

where P is the transmitted power of the radar; λ is its wavelength; σ is the scattering cross section of the target; A is the antenna **gain**; and S_{min} is the threshold signal.

radar reflectivity. In general, the measure of the efficiency of a **radar target** in intercepting and returning a radar **signal.** It depends upon the size, shape, aspect, and the dielectric properties at the surface of the target. It includes the effects of not only reflection (see **reflectivity**) but also **scattering** and **diffraction.**

radar reflector. A device capable of or intended for reflecting **radar** signals. See **corner reflector, parabolic reflector.**

radar scan. **1.** The searching motion of a radar **beam** in any of various path configurations; the pattern of the motion of a radar beam. **2. Radar scanning.**

radar scanning. The action or process of moving or directing a searching radar **beam.** See **circular scanning, conical scanning, helical scanning.**

radarscope. The **cathode-ray tube** or oscilloscope in a **radar set,** which displays the received **signal** in such a manner as to indicate range, bearing, etc. Sometimes called a *radar indicator.*

radar screen. **1.** The face of a **cathode-ray oscilloscope** used in a **radar set.** **2.** A net-

work of **radar** installations, or their emanations, serving, e.g., to detect strange aircraft.

radar set. An electronic apparatus consisting principally of a transmitter, antenna, receiver, and indicator for sending out scanning beams and receiving and displaying the reflected waves or the waves emitted by a radar beacon. See **radar.**

radar shadow. A condition in which **radar frequency** signals do not reach a region because of an intervening obstruction.

radar target. An object which reflects a sufficient amount of a **radar** signal to produce an **echo** signal on the radar screen.

radar volume. The volume in space that is irradiated by a given **radar.** For a **continuous-wave radar** it is equivalent to the antenna radiation pattern. For a **pulse radar** it is a function of the cross-section area of the beam of the antenna and the pulse length of the transmitted pulse.

radar wave. A transmitted or reflected **radio wave** used in **radar;** a radio wave in one of the **frequency bands** used for radar.

radial. Motion along a radius.

radial motion. Motion along a radius, or a component in such a direction, particularly that component of space motion of a **celestial body** in the direction of the line of sight.

radial velocity. In **radar,** that vector component of the **velocity** of a moving **target** that is directed away from or toward the ground station.

radian. The angle subtended at the center of a circle by an arc equal in length to a radius of the circle. It is equal to $360°/2\pi$ or approximately 57 degrees 17 minutes 44.8 seconds.

radiance. In radiometry, a measure of the intrinsic radiant **intensity** emitted by a radiator in a given direction. It is the **irradiance** (radiant flux density) produced by radiation from the source upon a unit surface area oriented normal to the line between source and receiver, divided by the solid angle subtended by the source at the receiving surface. It is assumed that the medium between the radiator and receiver is perfectly transparent; therefore, radiance is independent of **attenuation** between source and receiver.

If the radiant source is a perfectly diffuse radiator (that is, emits exactly according to **Lambert law**), then its radiance is equal to its **emittance** per unit solid angle. The radiance of a light source is termed *luminance* (formerly, brightness).

radiancy (*symbol* R, $\mathfrak{R}$, W). The rate of radiant-energy **emission** from a unit area of a source in all the radial directions of the overspreading hemisphere.

radiant. **1.** Pertaining to the **emission** or the measurement of **electromagnetic radiation.** Compare **luminous. 2.** In astronomy, the apparent location on the **celestial sphere** of the origin of the luminous **trajectories** of **meteors** seen during a **meteor shower.**

For convenience, the common meteor showers are named for the constellations of stars in which their radiants appear.

3. In describing auroras, a projected point of intersection of lines drawn coincident with auroral streamers; that is, the point from which the **aurora** seems to originate.

radiant density = radiant energy density.

radiant emittance. See **emittance,** sense **1.**

radiant energy (*symbol* U). **1.** The **energy** of any type of **electromagnetic radiation.** Also called *radiation.* **2.** Infrequently, any energy that may be radiated, as, for example, acoustic energy.

radiant energy density (*symbol* u). The instantaneous amount of radiant energy contained in a unit volume of propagating medium.

radiant energy thermometer. An instrument which determines the **black-body temperature** of a substance by measuring its thermal radiation.

The substance need not be thermally black over the whole spectrum, since it is possible to limit the measurement to those frequencies where it is black.

radiant flux (*symbol* Φ). The rate of flow of radiant energy.

radiant flux density = radiant flux per unit area.

When applied to a source, it is called *radiancy* or *radiant emittance* (*symbol* W).

When applied to a receiver, it is called *irradiancy* or *irradiance* (*symbol* H).

radiant heat. Infrared radiation.

This term, still used in certain engineering fields, is to be avoided since it confuses the distinct physical concepts of radiation and heat.

radiant intensity. Radiant **flux** per unit solid angle.

radiant temperature. The **temperature** obtained by use of a total radiation **pyrometer** when sighted upon a nonblack body.

This is always less than the true temperature.

radiating element. A basic subdivision of an **antenna** which in itself is capable of radiating or receiving **radiofrequency** energy.

radiation. **1.** The process by which electromagnetic energy is propagated through free space by virtue of joint undulatory variations in the electric and magnetic fields in space.

This concept is to be distinguished from conduction and convection.

A group of physical principles known as the **radiation laws** comprise, to a large extent, the current state of practical knowledge of the complex radiative processes.

2. The process by which energy is propagated through any medium by virtue of the **wave motion** of that medium, as in the propagation of sound waves through the atmosphere, or ocean waves along the water surface. **3.** = **radiant energy. 4.** = **electromagnetic radiation,** specifically, high-energy radiation such as **gamma rays** and **X-rays. 5.** Corpuscular emissions, such as α or β-radiation. **6.** = **nuclear radiation. 7.** = **radioactivity.**

radiation belt. An envelope of **charged particles** trapped in the **magnetic field** of a spatial body. See **Van Allen belt.**

radiation constants. Values used in **Planck law** and other radiation calculations. The first radiation constant (*symbol* $\mathbf{c}_1$) = 3.7415 erg centimeters squared per second. The second radiation constant (*symbol* $\mathbf{c}_2$) = 1.43879 centimeters °K. See **physical constants.**

radiation cooled. Of a structure, pertaining to the use of materials able to radiate heat at a rate such that the rate of increase of the temperature of the material is low.

radiation counter. An instrument used for detecting or measuring moving subatomic particles by a counting process.

radiation dose. The amount of radiation absorbed by a material, system, or tissue in a given amount of time; usually measured in one of the commonly accepted units as **roentgen, roentgen-equivalent-man, roentgen-equivalent-physical,** etc.

radiation laws. 1. The four physical laws which, together, fundamentally describe the behavior of black-body radiation: **(a)** the **Kirchoff law** is essentially a thermodynamic relationship between emission and absorption of any given wavelength at a given temperature; **(b)** the **Planck law** describes the variation of intensity of black-body radiation at a given temperature, as a function of wavelength; **(c)** the **Stefan-Boltzmann** law relates the time rate of radiant energy emission from a black body to its absolute temperature; **(d)** the **Wien law** relates the wavelength of maximum intensity emitted by a black body to its absolute temperature. **2.** All the more inclusive assemblage of empirical and theoretical laws describing all manifestations of radiative phenomena; e.g., **Bouguer law** and **Lambert law.**

radiation lobe. A portion of the **radiation pattern** bounded by one or two cones of **nulls.**

radiation medicine. That branch of medicine dealing with the effect of **radiation,** specifically high-energy radiation such as X-rays, gamma rays, and energetic particles on the body and with the prevention or cure of physiological injuries resulting from such radiation.

radiation pattern. A graphical representation of the **radiation** of an **antenna** as a function of direction. Cross sections in which radiation patterns are frequently given are vertical planes and the horizontal plane, or the principal electric and magnetic polarization planes. Also called *antenna pattern, lobe pattern, coverage diagram.*

Two types of radiation patterns should be distinguished. They are: **(a)** the free-space radiation pattern which is the complete lobe pattern of the antenna and is a function of the wavelength, feed system, and reflector characteristics, and **(b)** the field radiation pattern which differs primarily from the free-space pattern by the formation of interference lobes whenever direct and reflected wave trains interfere with each other as is found in most surface-based radars. The envelope of these interference lobes has the same shape, but, for a perfectly reflecting surface, it has up to twice the amplitude of the free-space radiation pattern.

radiation pressure (*symbol* P_r). **Pressure** exerted upon any material body by **electromagnetic radiation** incident upon it. See **Poynting-Robertson effect.**

This pressure is manifested whenever the electromagnetic momentum in a radiation field is changed, and is exactly twice as great when the radiation is reflected at normal incidence as it is when the radiation is entirely absorbed at normal incidence. The magnitude of any radiation-pressure effect is directly proportional to the intensity of the radiation, and is very small by most standards.

On a perfectly reflecting surface $P_r = u/3$ where u is radiation density, the amount of radiative energy per unit volume in the space above the surface. Radiation pressure has a perceptible effect on the orbit of earth satellites, especially those with a large reflecting surface such as Echo.

radiation pyrometer. See **pyrometer,** note.

radiation shield. 1. A device used on certain types of instruments to prevent unwanted **radiation** from biasing the measurement of a quantity. **2.** A device used to protect human beings from the harmful effects of **nuclear radiation,** cosmic radiation, or the like. **3.** = **heat shield.**

radiation sickness. A syndrome following intense acute exposure to **ionizing radiations.** It is characterized by nausea and vomiting a few hours after exposure. Further symptoms include bloody diarrhea, hemorrhage under the skin (and internally), epilation (hair falling), and a decrease in blood-cell level.

radiator. **1.** Any source of **radiant energy,** especially **electromagnetic radiation.** **2.** A device that dissipates the heat from something, as from water or oil, not necessarily by radiation only.

Generally, the application of the terms *radiator* (in sense 2) or *heat exchanger* to a particular apparatus depends upon the point of view: If the emphasis is upon merely getting rid of heat, *radiator* is most often used, or sometimes *cooler*; if the emphasis is upon transferring heat, *heat exchanger* is used—but these distinctions do not always hold true.

radio. **1.** Communication by **electromagnetic waves,** without a connecting wire. **2.** Pertaining to **radiofrequency,** as in *radio wave.*

radioactive. Exhibiting or pertaining to **radioactivity.**

radioactive gas. **1.** In atmospheric electricity, any one of the three radioactive inert gases, radon, thoron, and actinon, which contribute to atmospheric **ionization** by virtue of the ionizing effect of the alpha particles which each emits on disintegration. These three gases are isotopic to each other, all having atomic number 86. **2.** Any gaseous material containing **radioactive** atoms.

radioactive ionization gage. An **ionization gage** in which the ions are produced by radiations (usually **alpha particles**) emitted from a radioactive source.

radioactivity. **1.** Spontaneous disintegration of atomic nuclei with emission of **corpuscular or electromagnetic radiations.**

The principal types of radioactivity are alpha decay, beta decay, and isomeric transition.

To be considered as radioactive a process must have a measureable lifetime between approximately 10^{-10} second and approximately 10^{17} years. Radiations emitted within a time too short for measurement are called *prompt.* Prompt radiations such as gamma rays and X-rays are often associated with radioactive disintegrations.

2. The number of spontaneous disintegrations per unit mass and per unit time of a given unstable (radioactive) element, usually measured in curies.

radio altimeter. A device that measures the **altitude** of a craft above the terrain by measuring the elapsed time between transmission of **radio waves** from the craft and the reception of the same waves reflected from the terrain. Also called *radar altimeter.*

radio astronomy. **1.** The study of **celestial** objects through observation of **radiofrequency** waves emitted or reflected by these objects.

In this sense *radio astronomy* includes both the use of radiation emitted by the celestial bodies and of radiation originating on earth and reflected by celestial bodies (radar astronomy).

2. Specifically, the study of celestial objects by measurement of the radiation emitted by them in the radiofrequency range of the electromagnetic spectrum.

Radio astronomy measurements are usually of the **intensity** of the received signal but often include **polarization** of the signal and angular size of the source.

radio beacon. Any radio **transmitter,** together with its associated equipment, that emits signals enabling the determination, by means of suitable receiving equipment, of direction, distance, or position with respect to the beacon.

radio beam. See **beam.**

radiobiology. The study of the effects produced on living organisms by **radiation.**

radio blackout = blackout, sense **1.**

radio channel. A **frequency band** comprised of the emission **bandwidth,** the **interference guard bands,** and the **frequency tolerance.**

radio command. A radio **signal** to which a rocket, satellite, or the like responds.

radio control. **1.** Remote **control** of a pilotless airplane, a rocket, etc., by means of radio **signals** that activate controlling devices. **2.** Any radio apparatus used for this kind of control.

radio direction finder. A radio-receiving set, together with its associated equipment, used to determine the direction from which a radio **signal** is transmitted.

radio duct. A rather shallow, almost horizontal layer in the **atmosphere** through which vertical temperature and moisture gradients are such as to produce an **index of refraction** lapse rate of greater than −48 N-units per 1000 feet. Strong temperature, or moisture inversions, or both are necessary for the formation of radio ducts. The resulting **superstandard propagation** is such as to cause the curvature of rays traveling through it to be greater than that of the earth. Radio energy which originates within the duct and leaves the antenna at angles near the horizontal may thus be *trapped* within the layer. See **anomalous propagation, skip effect.**

The effect is similar to that of a mirage (it is sometimes called *radio mirage*), and radar targets may be detected at phenomenally long ranges if both target and radar are in the duct. The greater the elevation angle between radar and target, the less the possibility of serious distortion due to transmission through ducts. Ducts may be surface based or elevated, with thickness ranging from a few tens of feet up to a maximum of 1000 feet. Elevated ducts are generally associated with subsidence or frontal inversions and are seldom found above 15,000 to 20,000 feet.

radio energy. **Electromagnetic radiation** of greater wavelength (lower frequency) than **infrared** radiation, that is, of **wavelength** greater than about 1000 microns (0.01 centimeter). The high-frequency end of the radio-

radio frequency plasma etching — ions in the plasma (created by a RF electric field) strike a surface and remove surface atoms

energy spectrum is known as *microwave radiation*. See **frequency bands.**

radio fadeout = **fadeout.**

radiofrequency (*abbr* **RF**). **1.** A **frequency** at which coherent electromagnetic radiation of energy is useful for communication purposes.

Roughly, the radiofrequency of the electromagnetic spectrum lies between 10^4 and 10^{12} cycles per second. See **frequency bands.**

2. Specifically, the frequency of a given radio **carrier wave.**

radiofrequency band. See **frequency band.**

radio goniometer = **radio direction finder.**

radio guidance system. A **guidance** system that uses radio **signals** to guide an aircraft or spacecraft in flight; the **system** includes both the flight-borne equipment and the guidance station equipment on the ground.

radio hole. Strong **fading** of the radio **signal** at some position in space along an air-to-air or air-to-ground radio path. The effect is caused by the abnormal **refraction** of radio waves.

radio horizon. The locus of points at which direct rays from a radio **transmitter** become tangential to the earth's surface. Assuming a smooth surface, the distance of the horizon is given approximately by the equation

$$r = \sqrt{2h}$$

where r is the distance, statute miles, and h is the height, feet, of the **antenna** above the surface. See **effective earth radius, scatter propagation.** Compare **radar horizon.**

The horizon extends beyond (below) the geometrical and visible horizons as the result of normal atmospheric refraction. It may be decreased or increased in particular cases as standard propagation is replaced by **substandard propagation** or **superstandard propagation,** respectively.

Beyond the radio horizon, surface targets cannot be detected under normal atmospheric conditions although significant amounts of radio power have been detected in the diffraction zone below the horizon. It is now felt that this represents power scattered by turbulence-produced atmospheric inhomogeneities.

radio interferometer. An **interferometer** operating at radiofrequencies.

Radio interferometers are used in radio astronomy and in satellite tracking.

radio meteor. A **meteor** which has been detected by the reflection of a radio **signal** from the meteor trail of relatively high ion density (**ion column**). See **whistling meteor.** Compare **photographic meteor.**

Such an ion column is left behind a meteoroid when it reaches the region of the upper atmosphere between about 80 and 120 kilometers, although occasionally radio meteors are detected at higher altitudes. The maximum reflection occurs when the column is perpendicular to the line to the transmitter-receiver.

radiometer. An instrument for detecting and, usually, measuring **radiant energy.** Compare **bolometer.** See **actinometer, photometer.**

radiometer vacuum gage = **Knudsen gage.**

radiometric magnitude (*symbol* m_{rad}). The **magnitude** of a **celestial body** measured with reference to the total radiation observable through the atmosphere.

radiometry. The science of measurement of radiant energy.

In practice, there is no clear distinction between radiometry and **photometry** although *photometry* usually refers to measurements in the visible and near-visible range.

radio mirage. See **radio duct,** note.

radionuclide. A radioactive **nuclide;** an atom which emits corpuscular or electromagnetic radiation.

radiophare = **radio beacon.**

This term is commonly used in international terminology.

radiosonde. An instrument, usually balloon-borne, for the simultaneous measurement and transmission of meteorological data while moving vertically through the atmosphere. See **dropsonde.**

The instrument consists of transducers for the measurement of pressure, temperature, and humidity; a modulator for the conversion of the output of the transducers to a quantity which controls a property of the radiofrequency signal; a selector switch which determines the sequence in which the parameters are to be transmitted; and a transmitter which generates the radiofrequency carrier.

radiospectrum. The range of frequencies of **electromagnetic radiation** usable for radio communication.

The radiospectrum ranges from about 10 kilocycles per second to over 300,000 megacycles per second. Corresponding wavelengths are 30 kilometers to 1 millimeter. See **frequency bands.**

radio telescope. A device for receiving, amplifying, and measuring the intensity of **radio waves** originating outside the earth's atmosphere or reflected from a body outside the atmosphere.

A radio telescope usually includes a source of radiation of known power for calibration of the received signal.

The term *radio telescope* is not restricted to devices incorporating a paraboloidal *dish* antenna. A radio telescope can use any antenna or combination of antennas which will accept the radiation being studied.

radio theodolite = **radio direction finder.**

radio waves. Waves produced by **oscillation** of an electric charge at a **frequency** useful for radio communication. Formerly called *Hertzian waves.* See **frequency bands, electromagnetic radiation.**

radius vector. A straight line connecting a fixed reference point or center with a second

point, which may be moving; specifically, in astronomy, the straight line connecting the center of a **celestial body** with the center of a body which revolves around it, as *the radius vector of the moon.* See **polar coordinates, spherical coordinates.**

radix = **base** (of a number system).

radix point. The index which separates the **digits** associated with negative powers from those associated with the zero and positive powers of the base of the **number system** in which a quantity is represented. For example, *binary point, decimal point.*

radome. (From *ra*dar *dome.* Pronounced *ray-dome.*) A **dielectric** housing for an **antenna.**

ram air. Air entering an **airscoop** or **air inlet** as a result of the high-speed forward movement of a vehicle.

ramark. A fixed **radar frequency** facility which continuously emits a signal so that a bearing indication appears on a radar **display.** See **radar beacon.**

ram drag. The **drag** produced by the **momentum** of air entering an **airscoop** or an **air inlet** of an aeronautical vehicle in flight.

ramjet = **ramjet engine.**

ramjet engine. A type of **jet engine** with no mechanical compressor consisting of a specially shaped tube or duct open at both ends, the air necessary for combustion being shoved into the duct and compressed by the forward motion of the engine, where the air passes through a **diffuser** and is mixed with **fuel** and burned, the exhaust gases issuing in a **jet** from the rear opening. The ramjet engine cannot operate under static conditions. Often called a *ramjet.* Also called *Lorin tube.*

random. Eluding precise prediction, completely irregular. Compare **stochastic.**

In connection with probability and statistics, the term *random* implies collective or long-run regularity; thus, a long record of the behavior of a random phenomenon presumably gives a fair indication of its general behavior in another long record, although the individual observations have no discernible system of progression.

random error. Errors that are not systematic, are not erratic, and are not **mistakes.**

Such random errors are caused by disturbed elements in the measuring instrument and usually are of an approximately normal or **Gaussian distribution.** Such random errors are sometimes called *short-period errors.*

random number. An expression formed by a set of **digits** selected from a sequence of digits in which each successive digit is equally likely to be any of the digits.

random noise. An **oscillation** whose instantaneous amplitudes occur, as a function of time, according to a normal (Gaussian) curve. Also called *Gaussian noise, random Gaussian noise.*

random sample. A **sample** taken at random from a population.

random variable. A **variable** characterized by **random** behavior in assuming its different possible values. Mathematically, it is described by its probability distribution, which specifies the possible values of a random variable together with the probability associated (in an appropriate sense) with each value. A random variable is said to be *continuous* if its possible values extend over a continuum and *discrete* if its possible values are separated by finite intervals. Also called *variate.* See **probability theory.**

random vibration. An **oscillation** whose instantaneous **magnitude** is not specified for any given instant of time. The instantaneous magnitudes of a random oscillation are specified only by probability distribution functions giving the fraction of the total time that the magnitude, or some sequence of magnitudes, lies within a specified range.

A random vibration whose instantaneous magnitudes occur according to the **Gaussian distribution** is called Gaussian random vibration. Wide-band vibration amplitude is usually expressed as root-mean-square acceleration in gravitational units of acceleration g. The parameter used to specify the frequency distribution of a random vibration is power spectral density (g^2 per cycle per second), sometimes called *acceleration density* or *acceleration spectral density.*

range. 1. The difference between the maximum and minimum of a given set of numbers; in a **periodic** process it is twice the amplitude, i.e., the wave height. **2.** The distance between two objects, usually an observation point and an object under observation. See **slant range. 3.** A maximum distance attributable to some process, as in *visual range* or *the range of a rocket.* **4.** An area in and over which rockets are fired for testing, as *Atlantic Missile Range.* **5.** = **radar range.**

range attenuation. In **radar** terminology, the decrease in **power density** (flux density) caused by the divergence of the flux lines with distance, this decrease being in accordance with the inverse-square law.

For one-way transmission, this attenuation is proportional to $1/R^2$ where R is the range from the transmitter. For a radar and a point target, the range attentuation is proportional to $1/R^4$, the transmission being two way.

range error. The error in **radar range** measurement due to the **propagation** of radio energy through a nonhomogeneous atmosphere. This error is due to the fact that the velocity of radio-wave propagation varies with the **index**

of refraction and that ray travel is not in straight lines through actual atmospheres. The resulting range error is generally insignificant. Compare **azimuth error.**

range gating. The use of circuits in **radar** to suppress **signals** from all targets falling outside selected **range** limits.

range-height-indicator scope (*abbr* **RHI-scope**). A type of **radar** indicator (radarscope); an intensity-modulated **indicator** on which echoes are displayed in coordinates of slant range and elevation angle, simulating, thereby, a vertical cross section of the atmosphere along some azimuth from the radar.

The power of the signal returned from the target is used to modulate the intensity of the electron beam.

range marker. The index marks displayed on **radar** indicators to establish the scale or facilitate determination of the distance of a target from the radar. On the **plan-position-indicator** scope, for example, range markers take the form of concentric circles with the position of the radar at the center. See **azimuth marker.** Also called *distance marker.*

range only measurement of trajectory and recording (*abbr* **Romotar**). A nonambiguous spherical and elliptical, long-baseline, range-only **trajectory measuring system** utilizing phase comparison techniques with range-modulation frequencies.

The system consists of three or more receivers which track a **transponder** interrogated by a single transmitter. The reference signal from the ground transmitter is also received by the ground receivers. Simultaneous range measurements are made by the ground receivers, which are correlated with base timing from which space position can be computed by triangulation. The system operates on 387 and 417 megacycles.

range rate. The rate at which the distance from the measuring equipment to the target or signal source being tracked is changing with respect to time. See **radial velocity.**

range ring. A circle on a **plan position indicator,** particularly one with an adjustable diameter, to indicate distance from the antenna. See **distance marker.**

range safety officer. An official on a **rocket** test **range** whose responsibility is to supervise the planning and execution of each test to insure the maximum safety of all personnel and property within the range boundaries.

range strobe. An index mark which may be displayed on some types of radar **indicators** to assist in the determination of the exact **range** of a **target.**

range sweep. See **sweep,** note.

range wind. The component of a **ballistic** wind which is parallel to the longitudinal axis of the range.

ranging pulse. In a radar system the **pulse** used to measure the **range** of the object being tracked.

ranging system. A **radar** system which measures range (distance).

Rankine cycle. An idealized thermodynamic cycle consisting of two constant-pressure processes and two isentropic processes.

Rankine temperature scale. (*abbr* **°R**). A temperature scale with the degree-interval of the **Fahrenheit temperature scale** and the zero point at **absolute zero.** The **ice point** is thus 491.69 degrees Rankine and the **boiling point** of water is 671.69 degrees Rankine.

Rankine vortex. A two-dimensional circular **flow** in which a circular region about the origin is in solid rotation:

$$V/R = \text{Constant}$$

where V is the tangential speed and R is the distance from the origin; the region outside is free of vorticity, the speed being inversely proportional to the distance from the origin (as in the V–R vortex)

$$VR = \text{Constant}$$

This vortex has occasionally been used as a model for the surface wind distribution in a hurricane. It is characteristic of a cylindrical vortex in a liquid with a free surface.

raob. (From ***ra**diosonde **ob**servation.*) An observation of the verical distribution of temperature, pressure, and relative humidity, obtained by means of a **radiosonde.**

rarefaction wave = expansion wave.

rarefied gas dynamics. The study of the phenomena related to the molecular or non-continuum nature of gas **flow** at densities where

$$\lambda/l > 0.01$$

when λ is molecular mean free path and l is a characteristic dimension of the flow field.

Flow with $\lambda/l > 0.01$ is called *molecular flow.*
Flow with $\lambda/l < 0.01$ is called *continuum flow.*
Flow with $\lambda/l \approx 0.01$ to 0.1 is called *slip flow.*
Flow with $\lambda/l \approx 0.1$ to 10 is called *transition flow.*
Flow with $\lambda/l > 10$ is called *free molecule flow.*

Slip flow and *transition flow* are not always distinguished from each other. The value 1 is sometimes used instead of 10 as the boundary value for transition flow and free molecule flow.

rare gas = inert gas.

raster. The pattern followed by the **electron-beam** exploring element scanning the screen of a television transmitter or receiver.

raster line. One line of a raster, or scanning pattern.

rate gyro. A **single-degree-of-freedom** gyro having primarily elastic restraint of its spin axis about the output axis. In this gyro an output signal is produced by gimbal angular displacement, relative to the base, which is proportional to the angular rate of the base about the input axis.

rate integrating gyro. A **single-degree-of-freedom gyro** having primarily viscous restraint of its spin axis about the output axis. In this gyro an output signal is produced by gimbal angular displacement, relative to the base, which is proportional to the integral of the angular rate of the base about the input axis.

rate of decay. 1. Of a sound, the time rate at which the **sound pressure level** (or other stated characteristic) decreases at a given point and at a given time. A commonly used unit is the decibel per second. **2.** Of a **radioactive nuclide,** the number of nuclei of that nuclide changing (or disintegrating) per unit time. It is usually expressed as the instantaneous rate of decay by $-dN/dt$ where N is the total number of the state nuclides present at the given time t.

rate of incidence = impingement rate.

ratio deviation. In a **frequency modulation** system, the ratio of the maximum **frequency deviation** to the maximum modulating **frequency** of the system. Also called *modulation index.*

rational horizon = celestial horizon. See **horizon.**

RATO, Rato, or **rato.** (From ***r**ocket-**a**ssisted **t**ake-**o**ff.*) **1.** A **take-off** in which a rocket or rockets, commonly of the solid-fuel type, are used to provide additional thrust. Hence, *RATO bottle, Rato bottle, rato unit,* etc., a **rocket** so used. **2.** A RATO bottle or unit; the complete apparatus on an aircraft, comprising rockets, ignition system, etc., for assisted take-off. See **JATO.**

ratrace. A **magic-tee** modification for the acceptance of higher power; a circular loop of coaxial line closed upon itself and having four branching connections.

raw data. Data that is in a form ready for processing.

Different groups regard data in various forms as *raw,* dependent on their function. A photographic processing group may regard the latent image as raw data, a reading group may regard the photographic image as raw data, a computing group may regard certain digital data as raw data, and so on.

rawin. A measurement of wind direction and speed at altitude by radar tracking of a balloon-borne target.

rawinsonde. A combination **raob** and **rawin;** an observation of temperature, pressure, relative humidity, and winds-aloft by means of **radiosonde** and radio direction finding equipment or **radar** tracking.

ray. 1. An elemental **path** of radiated **energy;** or the energy following this path. It is perpendicular to the **phase fronts** of the **radiation.** See **incident ray, reflected ray, refracted ray. 2.** One of a series of lines diverging from a common point, as radii from the center of a circle. **3.** A long, narrow, light colored streak on the lunar surface originating from a **crater.** Rays range in length to over 150 kilometers and usually several radiate from the same crater, like spokes of a wheel.

Rayleigh atmosphere. An idealized **atmosphere** consisting of only those particles, such as molecules, that are smaller than about one-tenth the **wavelength** of all radiation incident upon that atmosphere. In such an atmosphere, simple **Rayleigh scattering** would prevail.

This model atmosphere is amenable to reasonably complete theoretical treatment, and hence has often served as a useful starting point in descriptions of the optical properties of actual atmospheres. The polarization of skylight, for example, exhibits almost none of the complexities found in the real atmosphere.

Rayleigh formula. See **aerodynamic force, drag, drag coefficient.**

Rayleigh law. See **Rayleigh scattering.**

Rayleigh limit. See **Rayleigh scattering.**

Rayleigh number. The nondimensional ratio between the product of buoyancy forces and heat advection and the product of viscous forces and heat conduction in a fluid. It is written as

$$N_{Ra} = \frac{g|\Delta_z T|\alpha d^3}{\nu k}$$

where g is the acceleration of gravity; $\Delta_z T$ is a characteristic vertical temperature difference in the characteristic depth d; α is the coefficient of expansion; ν is the kinematic viscosity; and k is the thermometric conductivity.

The Rayleigh number is equal to the product of the **Grashof** and **Prandtl numbers,** and is the critical parameter in the theory of thermal instability.

Rayleigh scattering. Any **scattering** process produced by spherical particles whose **radii** are smaller than about one-tenth the **wavelength** of the scattered **radiation.** Compare **Mie scattering.**

In Rayleigh scattering, the scattering coefficient varies inversely with the fourth power of the wavelength, a relation known as the *Rayleigh law.* The angular intensity polarization relationships for Rayleigh scattering are conveniently simple. For particles not larger than the Rayleigh limit, there is complete symmetry of scattering

about a plane normal to the direction of the incident radiation, so that the forward scatter equals the backward scatter. The Rayleigh scattering coefficient k_s is

$$k_s = \frac{2\pi^5}{3} n \left(\frac{m^2 - 1}{m^2 + 2}\right)^2 \frac{d^6}{\lambda^4}$$

where n is the number of scatterers of diameter d; m is the index of refraction; and λ is the wavelength of the radiation.

Rayleigh wave. **1.** A two-dimensional **barotropic disturbance** in a **fluid** having one or more discontinuities in the vorticity profile. **2.** A surface wave associated with the free boundary of a solid, such that a surface particle describes an **ellipse** whose major axis is normal to the surface and whose center is at the undisturbed surface. At maximum particle displacement away from the solid surface the motion of the particle is opposite to that of the wave.

The propagation velocity of a Rayleigh wave is slightly less than that of a shear wave in the solid; the wave amplitude of the Rayleigh wave diminishes exponentially with depth.

rays (*abbr* **R**). See **aurora.**

ray tracing. A procedure used in the graphical determination of the **path** followed by a single **ray** of radiant energy as it travels through media of varying **index of refraction.**

reaction balance. A type of thrust meter using a balance to measure the static **thrust** of a **rocket** or jet engine.

reaction engine. An engine that develops **thrust** by its reaction to a substance ejected from it; specifically, such an engine that ejects a **jet** or stream of gases created by the burning of fuel within the engine. Also called **reaction motor.**

A reaction engine operates in accordance with Newton third law of motion, i.e., to every action (force) there is an equal and opposite reaction. Both rocket engines and jet engines are reaction engines.

reaction motor = reaction engine.

reaction propulsion. **Propulsion** by reaction to a **jet** or jets ejected from one or more **reaction engines.**

reaction time. In human engineering, the interval between an input signal (physiological) or a stimulus (psychophysiological) and the response elicited by the signal.

reaction turbine. A type of **turbine** having rotor blades shaped so that they form a ring of **nozzles,** the turbine being rotated by the reaction of the **fluid** ejected from between the blades. Compare **impulse turbine.**

reactor = nuclear reactor.

reactor core. In a **nuclear reactor** the region containing the **fissionable** material.

read. In **computer** operations, to acquire information, usually from some form of **storage.** See **write.**

read in. In **computer** operations, to introduce information into **storage.**

readout. **1.** The action of a radio **transmitter** transmitting data either instantaneously with the acquisition of the data or by playing of a magnetic tape upon which the data have been recorded. See **instantaneous readout.** **2.** The data transmitted by the action described in sense **1.** **3.** In **computer** operations, to extract information from **storage.**

readout indicators. Any type of indicating instrument from which meaningful information and data can be directly obtained and used.

readout station. A recording or receiving radio station at which data are received from a **transmitter** in a probe, satellite, or other **spacecraft.**

real time. Time in which reporting on events or recording of events is simultaneous with the events.

For example, the real time of a satellite is that time in which it simultaneously reports its environment as it encounters it; the real time of a computer is that time during which it is accepting data.

real-time data. Data presented in usable form at essentially the same time the event occurs.

The delay in presenting the data must be small enough to allow a corrective action to be taken if required.

rearward acceleration. See **physiological acceleration.**

Réaumur temperature scale. A **temperature** scale in which, under a pressure of 1 atmosphere, the **ice point** is 0° and the **boiling point** of water is 80°.

rebreather. An **oxygen system** with a circuit closed to the atmosphere, to which oxygen is added to meet the user's needs; carbon dioxide and water vapor are removed from the expired gas.

received power. In **radar,** the power of a **target signal** received at the antenna. This power is normally of the order of microwatts as compared to the megawatts of transmitted power. Also called *scattered power.*

receiver. **1.** The initial component or sensing element of a measuring system. For example, the receiver of a thermoelectric thermometer is the measuring thermocouple. **2.** An instrument used to detect the presence of and to determine the information carried by **electromagnetic radiation.** A receiver includes circuits designed to detect, amplify, rectify, and shape the incoming **radiofrequency** signals received at the **antenna** in such a

manner that the information-containing component of this received energy can be delivered to the desired indicating or recording equipment.

receptor. A sensory nerve ending or organ in a living organism that is sensitive to physical or chemical stimuli.

reciprocal. **1.** A direction 180° from a given direction. **2.** The quotient of 1 divided by a given number.

reciprocal centimeter. See **wave number,** note.

reciprocating engine. An **engine,** especially an internal-combustion engine, in which a piston or pistons moving back and forth work upon a crankshaft or other device to create rotational movement.

reciprocity. See **principle of reciprocity.**

recognition. The psychological process in which an observer so interprets the visual stimuli he receives from a distant object that he forms a correct conclusion as to the exact nature of that object.

Recognition is a more subtle phenomenon than the antecedent step of detection, for the latter involves only the simpler process of interpreting visual stimuli to the extent of concluding that an object is present at some distance from the observer.

recombination. The process by which a positive and a negative **ion** join to form a neutral **molecule** or other neutral particle, also process by which radicals or dissociations species join to form molecules.

Recombination is applied both to the simple case of capture of free electrons by positive atomic or molecular ions, and also to the more complex case of neutralization of a positive small ion by a negative small ion or a similar (but much more rare) neutralization of large ions.

Recombination is, in general, a process accompanied by emission of radiation. The light emitted from the channel of a lightning stroke is recombination radiation as is **airglow.** The much less concentrated recombinations steadily occurring in all parts of the atmosphere where ions are forming and disappearing does not yield observable radiation.

The rate at which electrons, small ions, and large ions recombine is a function of their respective mobilities and of their concentrations. The former dependence is expressed in terms of the recombination coefficient of the particular ion type.

recombination coefficient. A measure of the specific rate at which oppositely charged **ions** join to form neutral particles (a measure of ion **recombination**). Compare **combination coefficient.**

recombination energy. The energy released as heat or light when two oppositely charged **ions** join to form a neutral atom or molecule, or two dissociated atoms combine to form a stable **molecule.**

recoverable. Of a **rocket** vehicle or one of its parts, so designed or equipped as to be located after flight and recovered with or without damage.

recovery. **1.** The procedure or action that obtains when the whole of a **satellite,** or a section, instrumentation package, or other part of a rocket vehicle is retrieved after a launch, as in *recovery was counted upon to give added data.* **2.** The conversion of **kinetic energy** to **potential energy** such as in the deceleration of air in the duct of a **ramjet engine.** Also called *ram recovery.* **3.** In flying, the action of a lifting vehicle returning to an equilibrium attitude after a nonequilibrium maneuver.

recovery capsule. A **capsule** designed to be recovered after reentry. See **reentry vehicle.**

recovery gear. The devices and equipment used to mark and locate a nose cone or other part of a **rocket vehicle** after impact.

recovery package. A package attached to a **reentry** or other body designed for recovery, containing devices intended to locate the body after **impact.**

This package may, for example, release a balloon that will buoy up a reentry body (if it impacts in water) and serve as a radio beacon or light.

recovery temperature. Short for *adiabatic recovery temperature.*

recrystallization. **1.** In metals, the change from one crystal structure to another, as occurs on heating or cooling through a critical temperature. **2.** The formation of a new strain-free grain structure from that existing in cold-worked metal, usually accomplished by heating.

rectangular curvilinear coordinates. See **curvilinear coordinates.**

rectifier. A static device having an asymmetrical conduction characteristic which is used to convert attending current into direct current.

A rotating device for this purpose is called a *converter.* Compare **inverter.**

recycle. **1.** In a **countdown** to stop the count and to return to an earlier point in the countdown, as in *we have recycled, now at T minus 80 and counting.* Compare **hold.** **2.** To give a completely new **checkout** to a rocket or other object.

redout. The condition occurring under **negative g** in which objects appear to have a red coloration due to uncertain causes, possibly venous congestion of engorged eyelids. Compare **blackout,** sense **3.**

red shift. In astronomy, the displacement of observed spectral lines toward the longer wavelengths of the red end of the spectrum. Compare **space reddening.**

The term *red shift* is applied both to the **Doppler effect** caused by the relative speed of recession of the

observed body and the gravitational or relativistic shift in which the frequency of light emitted by atoms in stellar atmospheres is decreased by a factor proportional to the mass-radius relationship of the star.

Red Spot Hollow. See **Great Red Spot.**

reduced frequency (*symbol* k). The frequency of **vibration** of a body, or of the variation of the **flow** behind the body, expressed as the circular frequency times the **representative length** of the body divided by the velocity of the flow.

redundancy. **1.** In **information theory:** of a source, the amount by which the logarithm of the number of symbols available at the source exceeds the average information content per symbol of the source.

The term *redundancy* has been used loosely in other senses. For example, a source whose output is normally transmitted over a given channel has been called *redundant,* if the channel utilization index is less than unity.

2. The existence of more than one means for accomplishing a given task, where all means must fail before there is an overall failure to the system.

Parallel redundancy applies to systems where both means are working at the same time to accomplish the task, and either of the systems is capable of handling the job itself in case of failure of the other system. *Standby redundancy* applies to a system where there is an alternative means of accomplishing the task that is switched in by a malfunction sensing device when the primary system fails.

Reech number. The reciprocal lg/V^2, of the **Froude number,** where g is the acceleration of gravity; l is a characteristic length; and V is a characteristic speed.

reentry. The event occurring when a **spacecraft** or other object comes back into the **sensible atmosphere** after being rocketed to higher altitudes; the action involved in this event.

reentry body. That part of a **space vehicle** that reenters the atmosphere after flight above the **sensible atmosphere.**

reentry nose cone. A **nose cone** designed especially for **reentry,** consisting of one or more chambers protected by an outer shield. See **heat sink.**

reentry trajectory. That part of a **rocket's** trajectory that begins at reentry and ends at target or at the surface.

If the rocket is unguided at reentry, its reentry trajectory is ballistic in character.

reentry vehicle. Any payload carrying **vehicle** designed to leave the **sensible atmosphere** and then return through it to earth.

This term applies both to return vehicles from orbital or space payloads and to **boostglide vehicles.**

reference ellipsoid. An ellipsoid of revolution used as a datum for geodetic measurements. See **geoid.**

reference frame = **coordinate system.**

reference line = **datum line.**

reference plane = **datum plane.**

reference point = **datum point.**

reference signal. In **telemetry,** the **signal** against which data-carrying signals are compared to measure differences in time, phase, frequency, etc.

referent. An assumed zero value of a quantity relative to which magnitudes of the quality are measured, or a structure having this zero value of the quantity; e.g., a voltage measured relative to the ground as a *referent.*

reflectance (*symbol* ρ). The ratio of the radiant **flux** reflected by a body to that incident upon it. Also called *reflection factor.*

For an opaque body, the sum of the reflectance and the absorptance for the incident radiation is unity $\rho + \alpha = 1$.

reflected code = **cyclic code.**

reflected ray. A **ray** extending outward from a point of reflection.

reflected wave. **1.** A **shock wave, expansion wave,** or **compression wave** reflected by another wave incident upon a wall or other boundary. **2.** In electronics, a radio wave reflected from a surface or object.

reflecting telescope. A telescope which collects light by means of a concave mirror.

reflection. The process whereby a surface of discontinuity turns back a portion of the incident radiation into the medium through which the radiation approached. See **albedo, reflectivity, radar reflectivity.**

For true reflection to occur there must be a real discontinuity of the **index of refraction** or at least it must change over an interfacial layer of thickness small compared to the wavelength of the radiation. If the change of refractive index is gradual (as may occur in a stratified medium) radiation may be returned by a process of continuous refraction, not to be confused with reflection. In radar, the term *reflection* is often applied to the return of radio energy from a volume of precipitation or cloud particles, where **scattering** is the important process.

When the scale of the irregularities on the reflecting surface is small compared to the wavelength, regular or specular reflection (also called *mirror reflection, regular reflection*) results; if the irregularities are large compared to the wavelength, diffuse reflection occurs. The process of reflection is not affected by wavelength except as the relative scale of the irregularities of the surface change with wavelength. The fraction of the incident radiation reflected does depend on wavelength because of the selective nature of the absorptivity and transmissivity. The idealized white body is a total reflector; a black body reflects none of the incident radiation.

The laws of specular reflection are: (first law) the reflected ray lies in the same plane as the incident ray and the normal to the surface at the point of incidence;

and (second law) the angle of reflection equals the angle of incidence, both measured from the normal to the surface.

reflection coefficient. A measure of the quality of **specular reflection** produced by a given surface; defined as the ratio of the radiant energy reflected along the geometrical reflection path to the total that is incident upon the surface. By definition, a reflection coefficient of 1.0 implies perfect specular reflection. Compare **reflectivity.**

Reflection coefficients of less than 1.0 occur either as a result of energy loss by absorption at the reflection surface, or by scattering of the energy out of the geometrical reflection path due to the diffuse or irregular nature of the reflecting surface. Note that the reflection coefficient varies with wavelength since a surface which might appear to be rough at very short wavelengths is much smoother to longer wavelength radiation. It also varies with polarization.

reflectivity. **1.** A measure of the fraction of **radiation** reflected by a given surface; defined as the ratio of the **radiant energy** reflected to the total that is incident upon that surface. Compare **reflection coefficient.** See **radar reflectivity.**

The reflectivity of any given substance is, in general, a variable strongly dependent upon the wavelength of the radiation in question.

The reflectivity of a given surface for a specified broad spectral range, such as the visible spectrum or the solar spectrum, is referred to as the *albedo.*

2. In thermal radiation, a property of a material, measured as the **reflectance** of a specimen of the material that is thick enough to be completely opaque and has an optically smooth surface.

reflector. **1.** In general, any object that reflects incident **energy;** usually it is a device designed for specific reflection characteristics. See **retroreflector, corner reflector, parabolic reflector, radar reflector.** **2.** In an antenna, a **parasitic element** located in a direction other than the general direction of the major lobe of radiation. **3.** A material of high **scattering cross section** that surrounds a reactor core to reduce the escape of neutrons, many of which are reflected back into the core. **4.** A **repeller.**

refracted ray. A **ray** extending onward from the point of **refraction.**

refracted wave. A **wave** that has had its direction of motion changed by **refraction.**

refracting telescope. A telescope which collects light by means of a lens or system of lenses. Also called *refractor.*

refraction. The process in which the direction of energy **propagation** is changed as the result of a change in density within the propagating medium, or as the energy passes through the interface representing a density discontinuity between two media. In the first instance the rays undergo a smooth bending over a finite distance. In the second case the **index of refraction** changes through an interfacial layer that is thin compared to the wavelength of the radiation; thus, the refraction is abrupt, essentially discontinuous. See **atmospheric refraction.** Compare **reflection, diffraction, scattering.**

refraction error. See **astronomical refraction error, terrestrial refraction error, curved-path error.**

refraction index = **index of refraction.**

refractive index = **index of refraction.**

refractive modulus = **modified index of refraction.**

refractivity. **1.** The algebraic difference between an **index of refraction** and unity.

For the atmosphere, refractivity may be more conveniently expressed in N-units:

$$N = (n - 1)\,10^6$$

The deviation of the refractivity at any altitude from the usual standard profile is expressed in B-units (for radiofrequencies up to 20 kilomegacycles):

$$B = N + 0.012h$$

where h is altitude in feet.

The deviation of the refractivity at any altitude from the gradient at which the refraction curvature of a tangential ray will match the curvature of the earth may be expressed in M-units:

$$M = N + 0.048h$$

where 0.048 is 10^6 divided by the radius of the earth in feet.

2. = **index of refraction.**

This usage should be discouraged.

refractometer. An instrument for measuring the **index of refraction** of a liquid, gas or solid.

refractor = **refracting telescope.**

refractory. A material, usually **ceramic,** that resists the action of heat, does not fuse at high temperatures, and is very difficult to break down.

refractory metal. A metal with melting point above 4000° F.

Usually refers to columbium, molybdenum, tantalum, or tungsten.

refrangible. Capable of undergoing **refraction.**

regeneration. **1.** = **positive feedback.** **2.** In **computer** operations, the process of restoring a **storage** device, whose information storing state may deteriorate, to its latest undeteriorated state. See **rewrite.**

regenerative cooling. The cooling of a part of an engine by the fuel or propellant being delivered to the combustion chamber; specifically, the cooling of a rocket-engine **combustion chamber** or **nozzle** by circulating the

fuel or **oxidizer,** or both, around the part to be cooled.

regenerative detector. A **demodulator** whose gain or conversion ratio is increased by the addition of positive **feedback** or regeneration at the carrier frequency.

The sensitivity, small-signal selectivity, and distortion are increased over those found in a detector without regeneration.

regenerative engine. A **liquid rocket engine** cooled by **regenerative cooling.**

regenerator. A device used in a **thermodynamic** process for capturing and returning to the process **heat** that would otherwise be lost. Also called a *heat exchanger* (which see).

region. A portion of the **ionosphere** usually characterized by a particular altitude or range of altitudes, in which concentrations of **free electrons** tend to form.

region of escape = exosphere.

register. A device capable of retaining information, often that contained in a small subset (e.g., one word) of the aggregate information in a digital **computer.** See **storage.**

regression. The statistical counterpart or analog of the functional expression, in ordinary mathematics, of one variable in terms of others. Thus, *regression curve, regression coefficient.*

regression of the nodes. Precessional motion of a set of **nodes.** See **precession.**

The expression is used principally with respect to the moon, the nodes of which make a complete westerly revolution in approximately 18.6 years.

regular reflection = specular reflection.

regular reflector = specular reflector.

reheat = reheating (especially in sense **1**).

reheating. 1. The addition of heat to a **working fluid** in an engine after a partial expansion. **2.** The retention of heat in a fluid, as after passing through a turbine stage, owing to the inefficiency of the stage.

relative. Of angle measurements in navigation, measured from the **heading** of a craft, as *relative bearing.*

relative angular momentum. The **moment** of the **relative momentum** about a point. See **angular momentum.**

relative coordinate system. Any **coordinate system** which is moving with respect to an **inertial coordinate system.**

Referred to a relative system, various apparent forces arise in Newton laws owing to motion of the system. See, e.g., **centrifugal force, coriolis force.**

relative distance. See **relative movement,** note.

relative humidity (*symbol U*). The (dimensionless) ratio of the actual **vapor pressure** of the air to the **saturation vapor pressure.** The corresponding ratios of **specific humidity** or of **mixing ratio** give approximations of sufficient accuracy for many purposes in meteorology. The relative humidity is usually expressed in percent. Also called *humidity.* See **absolute humidity, dew point.**

The ratio of mixing ratio to saturation mixing ratio is preferred as a definition of relative humidity by the International Meteorological Organization.

relative momentum. The product of the mass of a particle and its relative velocity; or, in the case of a fluid, the product of density and relative velocity. See **momentum.**

relative motion = apparent motion, relative movement. See **motion.**

relative movement. Motion of one object or body measured relative to another. Usually called *apparent motion* when applied to the change of position of a celestial body as observed from the earth. Also called *relative motion.*

The expression is usually used in connection with problems involving motion of one craft or vehicle relative to another, the direction of such motion being called *direction of relative movement* and the speed of such motion being called *speed of relative movement* or *relative speed.* Distance relative to a specified reference point, usually one in motion, is called *relative distance.*

relative position. A point defined with reference to another **position,** either fixed or moving.

The coordinates of such a point are usually **bearing,** true or relative, and distance from an identified reference point.

relative scattering function. See **relative scatter intensity.**

relative scatter intensity. For **scattering** of **radiation** under any given set of physical conditions: the ratio of the **radiant intensity** scattered in any given direction to the radiant intensity scattered in the direction of the incident beam.

The value of this ratio is a function of the angle between the direction in question and the direction of the incident beam. Thus, it may be symbolized as $f(\varphi)$, the relative scattering function. Compare **scattering function.** See **scatter angle.**

relative speed = speed of relative movement.

relative sunspot number. A measure of **sunspot** activity, computed from the formula

$$R = k(10g + f)$$

where R is the relative sunspot number; f is the number of individual spots; g is the number of groups of spots; and k a factor that varies with the observer (his personal equation), the seeing, and the observatory (location and instrumentation). Also called *sunspot number, sunspot*

relative number, *Wolf number*, *Wolf-Wolfer number*, *Zürich number*.

relative vorticity. See **absolute vorticity.**

relativistic. In general, pertaining to material, as a particle, moving at speeds which are an appreciable fraction of the **speed of light** thus increasing the mass.

relativistic mass equation. The equation

$$m = m_0 \, [1 - (v^2/c^2)]^{-1/2} = m_0/(1 - \beta^2)^{1/2}$$

where $\beta \equiv v/c$ for the relativistic mass m of a particle or body of **rest mass** m_0 when its velocity is v. See **relativistic velocity.**

relativistic particle. A particle with a velocity so large that its relativistic mass exceeds its **rest mass** by an amount which is significant for the computation or other considerations at hand. See **relativistic velocity.**

relativistic red shift. See **red shift,** note.

relativistic velocity. A velocity sufficiently high that some properties of a particle of this velocity have values significantly different from those obtaining when the particle is at rest. See **rest mass.**

The property of most interest is the mass. For many purposes, the velocity is relativistic when it exceeds about one-tenth the velocity of light. See also **Fitzgerald-Lorentz contraction.**

relativity. A principle that postulates the equivalence of the description of the universe, in terms of physical laws, by various observers, or for various frames of reference. See **relativistic mass equation, mass-energy equivalence.**

relativity theory. See **relativity.**

relaxation method. An iterative numerical method for solving elliptic partial differential equations, e.g., a Poisson equation.

relaxation time. **1.** In general, the time required for a system, object, or fluid to recover to a specified condition or value after disturbance. **2.** Specifically, the time taken by an exponentially decaying quantity to decrease in amplitude by a factor of $1/e = 0.3679$.

reliability. Of a piece of equipment or a system, the **probability** of specified performance for a given period of time when used in the specified manner.

rem. Abbreviation for **roentgen-equivalent-man.**

remaining body. That part of a **rocket** or **vehicle** that remains after the separation of a **fallaway section** or **companion body.**

In a multistage rocket, the remaining body diminishes in size successively as each section or part is cast away and successively becomes a different body.

remanence (*symbol B*). The magnetic **flux density** which remains in a magnetic **circuit** after the removal of an applied magnetomotive force. Also called *retentivity*.

This should not be confused with residual flux density. If the magnetic circuit has an airgap, the remanence will be less than the residual flux density.

remote control. **Control** of an operation from a distance, especially by means of electricity or electronics; a controlling switch, lever, or other device used in this kind of control; as in *remote-control armament*, *remote-control switch*, etc.

remote indicating. Of an instrument, displaying indications at a point remote from its sensing element, often by electrical or electronic means.

remote velocity. The **velocity** of an object taken as a whole relative to the surrounding **fluid** at a point undisturbed by the moving object. Distinguished from the **local velocity** of any of the object's parts.

renal. Pertaining to the kidneys.

rendezvous. **1.** The event of two or more objects meeting with zero **relative** velocity at a preconceived time and place. **2.** The point in **space** at which such an event takes place, or is to take place.

A rendezvous would be involved, for example, in servicing or resupplying a space station.

rep. Abbreviation for **roentgen-equivalent-physical.**

repeller. An **electrode** whose primary function is to reverse the direction of an **electron** stream. Also called *reflector*.

reset. **1.** To restore a **storage** device to a prescribed state. **2.** To place a **binary cell** in the initial or *zero* state. See **clear.**

residual. In **celestial mechanics** and **trajectory** analysis, the deviation between an observed and a computed value, usually in the sense observed minus computed.

residual flux density (*symbol* B_r). The magnetic **flux density** at which the magnetizing force is zero when the material is in a symmetrically magnetized condition. See **remanence.**

residual air. The volume of air remaining in the lungs after a maximal expiration.

residual load. Of a **vehicle,** the sum of the payload, all items directly associated with the payload, and other relatively fixed weights of the overall vehicle; calculated as the difference between gross weight and the sum of propellant, tank, structure, and power-plant weights.

residual stress. In structures, any **stress** in an unloaded body. These stresses arise from

local yielding of the material due to machining, welding, quenching, cold work, etc.

resistance (*symbol R*). **1.** In electricity, the factor by which the square of the instantaneous conduction current must be multiplied to obtain the power lost by heat dissipation or other permanent radiation of energy away from the electrical current. **2.** In mechanics, the opposition by frictional effects to forces tending to produce motion.

resistivity (*symbol* ρ). In electricity, a characteristic proportionality factor equal to the resistance of a centimeter cube of a substance to the passage of an electric current perpendicular to two parallel faces. Also called *specific resistance.*

$$R = \rho(l/A)$$

where R is the resistance of a uniform conductor, l is its length, A is its cross-sectional area, and ρ is its resistivity.

resolution. **1.** The ability of a film, a lens, a combination of both, or a **vidicon** system to render barely distinguishable a standard pattern of black and white lines.

When the resolution is said to be 10 lines per millimeter, it means that the pattern whose line plus space width is 0.1 millimeter is barely resolved, the finer patterns are not resolved, and the coarser patterns are more clearly resolved. In satellite television systems the limiting element is the television scanning pattern.

2. In **radar,** the minimum angular separation at the antenna at which two targets can be distinguished (a function of **beamwidth**); or the minimum range at which two targets at the same azimuth can be separated (equal to one-half the **pulse** length). **3.** Of a **gyro,** a measure of response to small changes in input; the maximum value of the minimum input change that will cause a detectable change in the output for inputs greater than the threshold, expressed as a percent of one half the input range.

resolving power. **1.** = **resolution,** senses **1** and **2.** **2.** In a unidirectional **antenna,** the reciprocal of its beam width measured in degrees.

The **resolution** of a directional radio system can be different from the resolving power of its antenna, since the resolution is affected by other factors.

resonance. **1.** The phenomenon of amplification of a **free wave** or **oscillation** of a system by a **forced wave** or oscillation of exactly equal **period.** The forced wave may arise from an impressed force upon the system or from a boundary condition. The growth of the resonant amplitude is characteristically linear in time. **2.** Of a system in **forced oscillation,** the condition which exists when any change, however small, in the **frequency** of excitation causes a decrease in the response of the system.

resonance frequency. A **frequency** at which **resonance** exists. Also called *resonant frequency.*

In case of possible confusion, the type of resonance must be indicated, as *velocity resonance frequency.*

resonant frequency = **resonance frequency.**

resonator. In radio and radar applications, a **circuit** which will **resonate** at a given **frequency,** or over a range of frequencies, when properly excited.

A very important type of resonator is the cavity resonator, a closed hollow volume having conducting walls. The frequency at which these cavities will resonate is a function of their volume and shape; thus, they are used for making accurate frequency comparisons and for generating radio frequencies, usually in the microwave region.

respiration. The interchange of gases of living organisms and the gases of the medium in which they live.

Respiration applies to the interchange by any channel as *pulmonary respiration, cutaneous respiration,* etc.

responder. **1.** In general, an instrument that indicates reception of an electric or electromagnetic **signal.** **2.** = **transponder.**

responder beacon = **transponder beacon.**

response. Of a device or **system,** the motion (or other output) resulting from an **excitation** under specified conditions.

Modifying phrases must be prefixed to the term *response* to indicate what kinds of input and output are being utilized.

The response characteristic, often presented graphically, gives the response as a function of some independent variable such as frequency or direction. For such purposes it is customary to assume that other characteristics of the input (for example, voltage) are held constant.

responsor. A radio **receiver** which receives the reply from a **transponder** and produces an output suitable for feeding to a **display** system.

A responsor is usually combined in a single unit with an interrogator, which sends out the pulse that triggers a transponder, the combined unit being called an *interrogator-responsor.*

restart. Specifically, the act of firing a **stage** of a **rocket** after a previous powered flight and a coast phase in a **parking orbit.**

rest mass. According to **relativistic** theory, the mass which a body has when it is at absolute rest. Mass increases when the body is in motion according to

$$m = m_0/\sqrt{1 - (v^2/c^2)}$$

where m is its mass in motion; m_0 is its rest mass; v is the body's speed of motion; and c is the speed of light.

Newtonian physics, in contrast with relativistic physics, makes no distinction between rest mass and mass in general.

restricted propellant. A **solid propellant** having only a portion of its surface exposed for burning, the other surfaces being covered by an **inhibitor.**

restrictor. In **solid-propellant rockets,** a layer of fuel containing no **oxidizer,** or of noncombustible material, adhered to the surface of the propellant so as to prevent burning in that region.

resultant. The sum of two or more **vectors.**

resultant wind. The vectorial average of all wind directions and speeds at a given place for a certain period.

Ret, Reti. International Astronomical Union abbreviations for *Reticulum.* See **constellation.**

retentivity = remanence.

Reti. International Astronomical Union abbreviation for *Reticulum.* See **constellation.**

reticle. A system of lines, wires, etc., placed in the focal plane of an optical instrument to serve as a reference. Also called *reticule.*

A crosshair is a hair, thread, or wire constituting part of a reticle.

reticule = reticle.

Reticulum (*abbr* **Ret, Reti**). See **constellation.**

retrace. See **trace,** note.

retrofire. To ignite a **retrorocket.**

retroflector = retroreflector.

retrograde motion. 1. Motion in an **orbit** opposite to the usual orbital direction of **celestial bodies** within a given system. Specifically, of a **satellite,** motion in a direction opposite to the direction of rotation of the **primary. 2.** The apparent motion of a planet westward among the stars. Also called *retrogression.*

retrogression = retrograde motion.

retropack. A rocket unit built into or strapped to a **spacecraft** that provides **retrothrust.**

retroreflection. Reflection wherein the reflected rays return along paths parallel to those of their corresponding incident rays. Also called *retroflection.*

retroreflector. Any instrument used to cause reflected **rays** to return along paths parallel to those of their corresponding incident rays. Also called *retroflector.*

One type of retroreflector, the corner reflector, is an efficient radar target.

retrorocket. (From *retro*acting.) A **rocket** fitted on or in a spacecraft, satellite, or the like to produce **thrust** opposed to forward motion.

retrothrust. Thrust used for a braking maneuver; reverse thrust.

retrosequence. The sequence of events preparatory to, and programmed to follow, the **retrofiring** for **spacecraft** reentry.

reverberation. 1. The persistence of **sound** in an enclosed space, as a result of multiple reflections after the sound source has stopped. **2.** The sound that persists in an enclosed space, as a result of repeated reflection or scattering, after the source of the sound has stopped.

reverberation time. In acoustics, the time required for the time average of the **sound energy density,** initially in a steady state, to decrease, after the source is stopped, to one-millionth of its initial value. The unit is the second.

reverse thrust. Thrust applied to a moving object in a direction to oppose the object's motion.

reversing layer. See **photosphere,** note.

revetment. A wall of concrete, earth, sandbags, or the like installed for protection, as against the blast of exploding fuel during a rocket **abort.**

revolution. 1. Motion of a **celestial body** in its orbit; circular motion about an **axis** usually external to the body.

In some contexts, the terms *revolution* and *rotation* are used interchangeably but, with reference to the motions of a celestial body, *revolution* refers to motion in an orbit or about an axis external to the body, whereas *rotation* refers to motion about an axis within the body. Thus, the earth revolves about the sun annually and rotates about its axis daily.

2. One complete cycle of the movement of a **celestial body** in its orbit, or of a body about an external axis, as *a revolution of the earth about the sun.*

revolve. To move in a path about an axis, usually external to the body accomplishing the motion, as in *the planets revolve about the sun.* Hence **revolution.** See **rotate.**

rewrite. In a **storage** device whose information storing state may be destroyed by **reading,** the process of restoring the device to its state prior to reading.

Reynolds number (*symbol* R, N_{Re}). (After Osborne Reynolds (1842–1912), English scientist.) A nondimensional parameter representing the ratio of the **momentum** forces to the **viscous** forces in fluid **flow.**

In aerodynamics, the Reynolds number of fluid flow about a body is often expressed as the fraction $\rho = Vl/\mu$, where ρ is the density of the fluid, V is its velocity, l is a characteristic dimension of the body, and μ is the coefficient of viscosity of the fluid.

See **critical Reynolds number, effective Reynolds number.**

As applied to the flow of gas through a circular tube the Reynolds number is a dimensionless quantity equal to the product of the gas density ρ, in grams per cubic centimeter; times the flow velocity $\mathbf{v}$, in centimeters per second; times the tube diameter d, in centimeters; divided by the viscosity coefficient η, in poises:

$$R = \rho \, vd/\eta$$

Reynolds stresses. In the mathematical treatment of a viscous, incompressible, homogeneous fluid in turbulent motion, terms which represent the transfer of momentum due to turbulent fluctuations.

RF (*abbr*) = **radio*f*requency.**

Rhea. A **satellite** of Saturn orbiting at a mean distance of 527,000 kilometers.

rhombic antenna. An **antenna** composed of long-wire radiators comprising the sides of a rhombus. The antenna usually is terminated in an impedance. The sides of the rhombus, the angle between the sides, the elevation, and the termination are proportioned to give the desired directivity.

rho-theta system. **1.** Any electronic navigation system in which position is defined in terms of distance, or radius ρ and **bearing** θ with respect to a transmitting station. Also called an *R-theta system.* **2.** Specifically, a **polar-coordinate** navigation system providing data with sufficient accuracy to permit the use of a computer which will provide arbitrary course lines anywhere within the coverage area of the system.

ribbon parachute. A type of parachute having a canopy consisting of an arrangement of closely spaced tapes. This parachute has high porosity with attendant stability and slight opening shock.

rice grains = **granules.**

rich. Of a combustible mixture: having a relatively high proportion of **fuel** to **oxidizer;** more precisely, having a value greater than **stoichiometric.**

Richardson number (*symbol* N_{Ri}). A nondimensional number arising in the study of shearing flows of a stratified **fluid:**

$$N_{Ri} = g\beta/(\partial u/\partial z)^2$$

where g is the acceleration of gravity; β is a representative vertical stability (commonly $\partial\theta/\theta\partial z$, where θ is potential temperature); and $\partial u/\partial z$ a characteristic vertical shear.

In Richardson's original interpretation, the Richardson number is a characteristic ratio of work done against gravitational stability to energy transferred from mean to turbulent motion. Theoretical studies have placed the critical Richardson number variously from $\frac{1}{4}$ to 2, with instability for smaller values and stability for greater.

right ascension. Angular distance east of the **vernal equinox;** the arc of the **celestial equator,** or the angle at the celestial pole, between the **hour circle** of the vernal equinox and the hour circle of a point on the **celestial sphere,** measured eastward from the hour circle of the vernal equinox through 24 hours.

Angular distance west of the vernal equinox, through 360°, is sidereal hour angle.

rill (from German *rille* meaning *groove*). A deep, narrow, depression on the lunar surface which cuts across all other types of lunar topographic features.

ring around. Self-**interrogation** of a **beacon** due to insufficient isolation between receiver and transmitter, i.e., the beacon transmitter pulse passes through the receiver and retriggers the transmitter.

ring counter chain. A series of **bistable elements** triggered in sequence.

An open chain is reset by an externally applied reset pulse; a closed chain, by feedback from the last element in the chain.

ringwall. See **lunar crater.**

riometer = ***r*elative *i*onospheric *o*pacity *meter*).**

Rirti (*abbr*). ***R*ecording *i*nf*r*ared *t*racking *i*nstrument.**

rise time. The time required for the leading edge of a **pulse** to rise from one-tenth of its final value to nine-tenths of its final value. Rise time is proportional to time constant. See **decay time.**

rizalite. See **tektite.**

Robitzsch actinograph. A **pyranometer** developed by M. Robitzsch. Its design utilizes three bimetallic strips which are exposed horizontally at the center of a hemispherical glass bowl. The outer strips are white reflectors, and the center strip is a blackened absorber. The bimetals are joined in such a manner that the pen of the instrument deflects in proportion to the difference in temperature between the black and white strips.

rockair. A high-altitude sounding system consisting of a small **solid-propellant** research **rocket** carried aloft by an aircraft. The rocket is fired while the aircraft is in vertical ascent.

rocket. **1.** A projectile, pyrotechnic device, or flying **vehicle** propelled by a **rocket engine.** **2.** A **rocket engine;** any one of the *combustion chambers* or tubes of a multichambered **rocket engine.**

rocket airplane. An airplane using a **rocket** or rockets for its chief or only propulsion.

rocket-assisted take-off. The full term for **RATO.**

rocket booster. A **booster,** senses **2** and **3.**

rocket engine. A **reaction engine** that contains within itself, or carries along with itself, all the substances necessary for its operation or for the consumption or combustion of its **fuel,** not requiring intake of any outside substance and hence capable of operation in outer space. Also called *rocket motor.*

Chemical rocket engines contain or carry along their own fuel and oxidizer, usually in either liquid or solid form, and range from simple motors consisting only of a combustion chamber and exhaust nozzle to engines of some complexity incorporating, in addition, fuel and oxygen lines, pumps, cooling systems, etc., and sometimes having two or more combustion chambers. Experimental rocket motors have used neutral gas, ionized gas, and plasmas as propellants. See **liquid-propellant rocket engine, solid-propellant rocket engine, ion rocket, plasma rocket.**

rocket fuel. A **fuel,** either liquid or solid, developed for, or used by, a **rocket.**

rocket launcher. A device for launching a **rocket.** See **launcher.**

Rocket launchers are wheel mounted, motorized, or fixed for use on the ground; or they are mounted on aircraft, as under the wings; or they are installed below or on the decks of ships.

rocket motor = rocket engine.

rocket nozzle. The exhaust **nozzle** of a **rocket.**

rocket plane. An airplane powered by **rocket engines.**

rocket propellant (*abbr* **RP**). **1.** Any agent used for consumption or combustion in a rocket and from which the rocket derives its thrust, such as a **fuel,** oxidizer, additive, catalyst, or any compound or mixture of these. **2.** The ejected **fluid** in a nuclear rocket.

rocket propulsion. Reaction propulsion by a **rocket engine.**

rocket ramjet. A **ramjet engine** having a **rocket** mounted within the ramjet duct, the rocket being used to bring the ramjet up to the necessary operating speed. Sometimes called a *ducted rocket.*

rocketry. The science or study of **rockets,** including theory, research, development, experimentation, and application; the art or science of using rockets.

rocket ship. An aircraft, space-air vehicle, or spacecraft using **rocket propulsion.**

rocket sled. A sled that runs on a rail or rails and is accelerated to high velocities by a **rocket engine.**

This sled is used in determining g-tolerances and for developing crash survival techniques. Rocket sleds are at Edwards Air Force Base, Holloman Air Force Base, and the Naval Ordnance Test Station. See **snort track.**

rocketsonde = meteorological rocket.

rocket thrust. The **thrust** of a **rocket engine** usually expressed in pounds.

On a test stand, rocket thrust may be measured by use of strain gages, thrust-balancing pistons, dynamometers, or spring scales, each calibrated in pounds to represent the static weight moved by the engine.

rocket vehicle. A **vehicle** propelled by a **rocket engine,** used to place a satellite in orbit, place a missile upon target, carry a passenger over a rail as on a rocket sled, etc.

rockoon. A high-altitude **sounding** system consisting of a small **solid-propellant** research **rocket** carried aloft by a large plastic balloon.

The rocket is fired near the maximum altitude of the balloon flight. It is a relatively mobile sounding system and has been used extensively on shipboard.

rod. A type of photoreceptive cell in the retina of the mammalian eye. Rods are involved in detection of movement and **scotopic vision** (night vision).

rod threshold. The dimmest illumination in which the **rods** of the retina can function.

roentgen. A unit of radiation, that quantity of X-rays or gamma rays which will produce, as a consequence of ionization, 1 electrostatic unit of electricity in 1 cubic centimeter of dry air measured at 0° C and standard atmospheric pressure.

roentgen-equivalent-man (*abbr* **rem**). A unit of radiation which when absorbed by a human being, produces the same effect as the absorption of 1 **roentgen** of high-voltage **X-rays.**

roentgen-equivalent-physical (*abbr* **rep**). A unit measuring a purely physical effect of **radiation** by the number of ion pairs produced per unit volume of target material per time unit. One rep is equivalent to the absorption of 93 ergs per gram of tissue.

Roentgen ray = X-ray.

roll. 1. The act of rolling; rotational or oscillatory movement of an aircraft or similar body about a **longitudinal axis** through the body—called *roll* for any degree of such rotation. **2.** The amount of this movement, i.e., the angle of roll.

roll axis. A **longitudinal axis** through an aircraft, rocket, or similar body, about which the body rolls.

A roll axis may be a body, wind, or stability axis, or any other lengthwise axis.

rolling axis = roll axis.

rolling moment. A **moment** that tends to rotate an aircraft, a rocket, etc., about a **longitudinal axis.** This moment is considered positive when it tends to depress the starboard side of the body.

roll out. In computer terminology, to read out of a **storage** device by simultaneously increasing by one the value of the digit in each column and repeating this r *times* (*where* r *is the* **radix**) and, at the instant the representation changes from $(r - 1)$ to zero: generating a particular **signal,** or terminating a sequence of signals, or originating a sequence of signals.

Romotar (*abbr*) = ***r**ange-**o**nly **m**easurement **o**f **t**rajectory **a**nd **r**ecording.*

root chord. In aerodynamics, the **chord** of a lifting surface at the intersection of that surface with its supporting body, e.g., *wing root chord.*

root-mean-square error (*symbol* σ). In statistics, the square root of the **arithmetic mean** of the squares of the deviations of the various items from the arithmetic mean of the whole. Also termed *standard deviation.*

root-mean-square sound pressure = effective sound pressure.

rope. Code name for **window,** sense **2.**

rotate. To turn about an internal axis. Said especially of **celestial bodies.** Hence **rotation.** Compare **revolve.**

rotating cylinder gage. A type of **molecular drag gage.**

rotating disk gage. A type of **molecular drag gage.**

rotating Reynolds number. A nondimensional number arising in problems of a rotating viscous **fluid.** Also called *rotation Reynolds number.*

It may appear either as $\Omega h^2/\nu$, in which case it equals one-half the square root of the **Taylor number,** or as $\Omega r^2/\nu$, where r is a suitable radius, h is a representative depth, Ω is the absolute angular speed, and ν is the kinematic viscosity.

rotation. **1.** Turning of a body about an axis within the body, as *the daily rotation of the earth.* See **revolution. 2.** One turn of a body about an internal axis, as *a rotation of the earth.*

rotational speed (*symbol* n). Revolutions per unit time.

rotational wave = shear wave.

rotation Reynolds number = rotating Reynolds number.

Roti (*abbr*). ***R**ecording **o**ptical **t**racking **i**nstrument.*

rotor. See **gyro.**

rotor angular momentum (*symbol* $\boldsymbol{H}$). Of a **gyro,** the product of spin **angular velocity** and **rotor moment of inertia,** usually expressed in gram centimeters squared per second. It is a measure of the ability of a gyrorotor to maintain the **spin axis** fixed in space.

rotor moment of inertia. The **moment of inertia** of a **gyro** rotor about its **spin axis.**

rounding error. In computations, the error resulting from deleting the less significant **digits** of a quantity and applying some rule of correction to the part retained. Also called *round-off error.*

round off. To delete less significant **digits** from a number and possibly apply some rule of correction to the part retained.

round-off error = rounding error.

routine. A set of **instructions** arranged in proper sequence to cause a **computer** to perform a desired operation, such as the solution of a mathematical problem.

RP (*abbr*). = ***r**ocket **p**ropellant.* Used with a number in designations of different propellants, as in *RP–1.*

RP-1. A rocket **fuel** consisting essentially of kerosene.

R-theta system = rho-theta system.

R-T unit. The receiver-transmitter portion of a **radar beacon** system.

rubber-base propellant. A **solid propellant** mixture in which the oxygen supply is obtained from a perchlorate and the fuel is provided by a synthetic rubber latex.

rumble. A form of **combustion instability,** especially in a **liquid-propellant rocket engine,** characterized by a low-pitched, low-frequency rumbling noise; the noise made in this kind of combustion.

rupture disk = burst disk.

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S

sabot. A device fitted around or in back of a **projectile** in a gun barrel or launching tube to support or protect the projectile or to prevent the escape of gas ahead of it.

The sabot separates from the projectile after launching.

Sagitta (*abbr* **Sge, Sgte**). See **constellation.**

Sagittarius (*abbr* **Sgr, Sgtr**). See **constellation.**

salvo launch. Act of launching two or more **rockets** simultaneously.

sample. In statistics, a group of observations selected from a statistical **population** by a set procedure. See **random sample.**

Samples may be taken at random or systematically. The sample is taken in an attempt to estimate the population.

sandwich. Of **sandwich construction,** as in *sandwich panel, sandwich skin,* etc.

sandwich construction. A type of construction in which two sheets, sides, or plates are separated by a core of stiffening material, generally lightweight. See **honeycomb core.**

Sarah. (From *s*earch *a*nd *r*escue *a*nd *h*oming.) A radio **homing** device originally designed for personnel rescue and now used in spacecraft **recovery** operations at sea.

saros. The **eclipse** cycle of about 18 years, almost the same length as 223 **synodical months.** See **lunar cycle.**

At the end of each saros the sun, moon, and **line of nodes** return to approximately the same relative positions and another series of eclipses begins, closely resembling the series just completed.

satellite. **1.** An attendant body that revolves about another body, the **primary;** especially in the solar system, a secondary body, or moon, that revolves about a planet. See table XIII for a list of satellites of the solar system. **2.** A manmade object that revolves about a spatial body, such as Explorer I orbiting about the earth. See **spacecraft,** table XIV. **3.** Such a body intended and designed for orbiting, as distinguished from a companion body that may incidentally also orbit, as in *the observer actually saw the orbiting rocket rather than the satellite.* **4.** An object not yet placed in orbit, but designed or expected to be launched into an orbit.

satelloid. A **vehicle** that revolves about the earth or other body, but at such altitudes as to require sustaining **thrust** to balance **drag.**

saturation-adiabatic lapse rate. A special case of **process lapse rate,** defined as the rate of decrease of temperature with height of an air **parcel** lifted in a saturation-adiabatic process through an atmosphere in **hydrostatic equilibrium.** Also called *moist-adiabatic lapse rate.*

Owing to the release of latent heat, this lapse rate is less than the **dry-adiabatic lapse rate,** and the differential equation representing the process must be integrated numerically. Wet-bulb potential temperature is constant with height in an atmosphere with this lapse rate.

saturation vapor pressure. **1.** The **vapor pressure** of a system, at a given temperature, wherein the vapor of a substance is in equilibrium with a plane surface of the pure liquid or solid phase of that substance; that is, the vapor pressure of a system that has attained saturation but not supersaturation. Compare **equilibrium vapor pressure, vapor tension.**

The saturation vapor pressure of any pure substance, with respect to a specified parent phase, is an intrinsic property of that substance and is a function of temperature alone (see **Clapeyron-Clausius equation**).

2. = **equilibrium vapor pressure.**

Saturn. See **planet,** table.

saturnographic. Referring to positions on Saturn measured in **latitude** from Saturn's **equator** and in **longitude** from a reference **meridian.**

S-band. A **frequency band** used in **radar** extending approximately from 1.55 to 5.2 kilomegacycles per second.

scalar. Any physical quantity whose field can be described by a single numerical value at each point in space.

A scalar quantity is distinguished from a **vector** quantity by the fact that a scalar quantity possesses only **magnitude,** whereas a vector quantity possesses both magnitude and direction.

scalar acceleration. The square root of the sum of the squares of three **orthogonal** components of an **acceleration.**

scalar product. A **scalar** equal to the product of the magnitudes of any two **vectors** and the cosine of the angle θ between their positive directions. Also called *dot product, direct product, inner product.* See **vector product.**

For two vectors A and B, the scalar product is most

TABLE XIII.—SATELLITES OF THE SOLAR SYSTEM[a]

		Mean distance, 10^3 km	Sidereal period, days	Synodic period, days	Inclination of orbit to planet's equator ° ′	Eccentricity of mean orbit	Magnitude at mean opposition distance
Earth							
	Moon	384·4	27·32166	29·531	Var.	0·05490	—12·5
Mars							
I	Phobos	9·4	0·31891	0·319	0 57	0·0210	11
II	Deimos	23·5	1·26244	1·265	1 18	0·0028	12
Jupiter							
V		181	0·49818	0·498	0 24	0·003	13
I	Io	422	1·76914	1·770	0	0	5·5[b]
II	Europa	671	3·55118	3·554	0	0	6·1[b]
III	Ganymede	1071	7·15455	7·166	0	0	5·1[b]
IV	Callisto	1884	16·68902	16·754	0	0	6·2[b]
VI		11480	250·57	266	27 38	0·15798	14·7
VII		11740	259·65	276	24 46	0·20719	18
X		11860	263·55	281	29 01	0·13029	19
XII		21200	631·1		147	0·16870	18
XI		22600	692·5		164	0·20678	19
VIII		23500	738·9		145	0·378	17·0
IX		23700	758		153	0·275	18·6
Saturn							
I	Mimas	186	0·94242	0·943	1 31	0·0201	12·1
II	Enceladus	238	1·37022	1·370	0 01	0·00444	11·7
III	Tethys	295	1·88780	1·888	1 06	0	10·6
IV	Dione	378	2·73692	2·738	0 01	0·00221	10·7
V	Rhea	527	4·51750	4·519	0 21	0·00098	10·0
VI	Titan	1222	15·94545	15·969	0 20	0·0289	8·3
VII	Hyperion	1481	21·27666	21·319	0 26	0·104	15
VIII	Iapetus	3562	79·33082	79·920	14 43	0·02828	10·8
IX	Phoebe	12960	550·45	523·7	150	0·16326	14
Uranus							
V	Miranda	124	1·414	1·4	0	<0·01	17
I	Ariel	192	2·52038	2·521	0	0·0028	14
II	Umbriel	267	4·14418	4·145	0	0·0035	14
III	Titania	438	8·70588	8·708	0	0·0024	14
IV	Oberon	587	13·46326	13·469	0	0·0007	14
Neptune							
I	Triton	354	3·87683	5·877	159 57	0	14
II	Nereid	5570	359·4	362	27 27	0·76	19

[a] From the *Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac 1961.*
[b] Variable

commonly written A·B, read *A dot B*, and occasionally as (AB). If the vectors A and B have the components A_x, B_x, A_y, B_y, and A_z, B_z along rectangular Cartesian x, y, and z axes, respectively, then

$$A \cdot B = A_xB_x + A_yB_y + A_zB_z = |A|\,|B| \cos\theta = AB\cos\theta$$

If a scalar product is zero, one of the vectors is zero or else the two are perpendicular.

scalar velocity. The square root of the sum of the squares of three **orthogonal** components of a **velocity.**

scale effect. Any variation in the nature of the **flow** and in the force coefficients associated with a change in value of the **Reynolds number,** i.e., caused by change in size without change in shape.

scale height (*symbol* h, h_s). A measure of the relationship between density and temperature at any point in an **atmosphere;** the thickness of a **homogeneous atmosphere** which would give the observed temperature:

$$h = kT/mg = R^*T/Mg$$

where k is the **Boltzmann constant;** T is the absolute temperature; m and M are the mean molecular mass and weight, respectively, of the layer; g is the acceleration of gravity; and R^* is the universal gas constant. Compare **virtual height.**

scale model. A model of a different size from its prototype and having dimensions in some constant ratio to the dimensions of the prototype, especially such a model of smaller size than its prototype.

scale of 10 counter = decade counter.

scaler. A device that produces an output **pulse** whenever a prescribed number of input pulses have been received. Also called *scaling circuit.*

The number of input pulses per output pulse of a scaler is termed the *scaling factor.* A *binary scaler* is a scaler whose scaling factor is 2. A *decade scaler* is a scaler whose scaling factor is 10.

scaling circuit = scaler.

scaling factor. See **scaler,** note.

scanner. A radar mechanism incorporating a rotatable antenna, or radiator, motor drives, mounting, etc., for directing a searching **radar beam** through space and imparting target information to an indicator. See **parabolic reflector.**

scanning. In **radar,** the motion of the radar **antenna** assembly when searching for **targets.**

Scanning usually follows a systematic pattern involving one or more of the following: (a) In horizontal scanning (or searchlighting), the antenna is continuously rotated in azimuth around the horizon or in a sector (sector scanning); used to generate plan-position-indicator-scope displays. (b) Vertical scanning is accomplished by holding the azimuth constant but varying the elevation angle of the antenna; used in height-finding radars to generate the relative-height-indicator-scope display. (c) For conical scanning, a somewhat offcenter radiating element is rotated while its parabolic reflector is fixed in position so that the radiated beam generates a conically shaped volume with the antenna at the apex; used to determine accurate bearing and elevation angle of targets and employed in automatic tracking radars. (d) In helical scanning (or spiral scanning) the azimuth and elevation angle of the antenna are constantly varied so that at a given distance from the radar the radiated beam generates the surface of a hemisphere; used for radio direction finding, in certain types of search radars, and in tracking radars to search areas for targets.

scaphandre = full pressure suit.

scatter. 1. = scattering. 2. The relative dispersion of points on a graph, especially with respect to a mean value, or any curve used to represent the points. See dispersion. **3.** To accomplish **scattering.**

scatter angle. The angle between any given **ray** of scattered radiation and the incident ray. See **relative scatter intensity, scattering.**

Convention varies as to whether this angle is measured with respect to the direction in which the incident radiation was advancing or with respect to the direction from scatterer to radiation source.

scatter communication. See **scatter propagation,** note.

scattered power = received power.

scatterer = scattering particle.

scattering. The process by which small particles suspended in a medium of a different **index of refraction** diffuse a portion of the incident **radiation** in all directions. In scattering, no energy transformation results, only a change in the spatial distribution of the radiation. Also called *scatter.*

Along with absorption, scattering is a major cause of the attenuation of radiation by the atmosphere. Scattering varies as a function of the ratio of the particle diameter to the wavelength of the radiation. When this ratio is less than about one-tenth, **Rayleigh scattering** occurs in which the scattering coefficient varies inversely as the fourth power of the wavelength. At larger values of the ratio of particle diameter to wavelength, the scattering varies in a complex fashion described by the **Mie theory;** at a ratio of the order of 10, the laws of geometric optics begin to apply.

scattering area coefficient. The dimensionless ratio of the **scattering cross section** to the geometric **cross section** of a **scattering particle.** Also called *scattering area ratio.*

scattering area ratio = scattering area coefficient.

scattering coefficient. A measure of the **attenuation** due to **scattering** of radiation as it traverses a medium containing **scattering particles.** Also called *total scattering coefficient.*

scattering cross section. The hypothetical area normal to the incident **radiation** that would geometrically intercept the total amount of radiation actually scattered by a **scattering particle.** It is also defined, equivalently, as the cross-section area of an isotropic scatterer (a sphere) which would scatter the same amount of radiation as the actual amount. Also called *extinction cross section, effective area.*

scattering function. The **intensity** of scattered **radiation** in a given direction per lumen of flux incident upon the **scattering** material.

scattering gage = scattering-type pressure gage.

scattering loss. That part of the **transmission loss** which is due to **scattering** within the medium or due to roughness of the reflecting surface.

scattering particle. The small **particles** responsible for **scattering.**

scattering power. In radar terminology, the ratio of the total power scattered by a **target** to the power in the incident wave, independent of the direction of **scattering.** The scattering power measures the loss of energy by **absorption** in the scatterers. Also called *total scattering cross section.* Compare **radar reflectivity.**

scattering-type pressure gage. An **ionization gage** in which measurement is made of the **electrons** scattered by collision of the gas molecules with the electrons from a p-particle emitter.

scatter propagation. Specifically, the long-

range **propagation** of **radio** signals by **scattering** due to **index-of-refraction** inhomogeneities in the lower atmosphere. Also called *tropospheric propagation.*

Recognition of this process and the development of specialized equipment (basically, more powerful transmitters and sensitive receivers) has greatly increased the range of VHF and UHF communication. The over-all technique is known as *scatter communication.*

schlieren. (German, *streaks, striae*). **1.** Regions of different density in a **fluid,** especially as shown by special apparatus. **2.** Pertaining to a method or apparatus for visualizing or photographing regions of varying density in a field of **flow.** See **schlieren photography, scintillation.**

Used in compounds, such as *schlieren lens, schlieren method, schlieren photograph,* etc.

schlieren method. See **schlieren.**

schlieren photography. A method of photography for **flow** patterns that takes advantage of the fact that light passing through a density gradient in a gas is **refracted** as though it were passing through a prism. Compare **shadowgraph.**

Schneider index. A composite weighted index of pulse and blood-pressure response to exercise, utilized as a test of physical efficiency.

Schuler pendulum. A hypothetical pendulum with a **period** of 84 minutes.

A simulated Schuler pendulum carried in a vehicle moving in the earth's **gravitational field** would always indicate the true vertical.

Schuler tuning. Adjusting a system performing the function of a pendulum so that it has a **period** of 84 minutes. See **Schuler pendulum.**

Schumann-Runge bands. See **absorption band.**

Schumann-Runge continuum. See **absorption band.**

scintillating counter = scintillation counter.

scintillation. **1.** Generic term for rapid variations in apparent position, brightness, or color of a distant luminous object viewed through the **atmosphere.**

If the object lies outside the earth's atmosphere, as in the case of stars and planets, the phenomenon is termed *astronomical scintillation*; if the luminous source lies within the atmosphere, the phenomenon is termed *terrestrial scintillation.* As one of the three principal factors governing astronomical seeing, scintillation is defined as variations in **luminance** only.

It is clearly established that almost all scintillation effects are caused by anomalous refraction occurring in rather small parcels or strata of air, schlieren, whose temperatures and hence densities differ slightly from those of their surroundings. Normal wind motions transporting such schlieren across the observer's line of sight produce the irregular fluctuations characteristic of scintillation. Scintillation effects are always much more pronounced near the horizon than near the zenith. Parcels of the order of only centimeters to decimeters are believed to produce most of the scintillatory irregularities in the atmosphere.

2. A flash of light produced in a **phosphor** by an **ionizing** event. See **scintillation counter. 3.** On a radar display, a rapid apparent displacement of the **target** from its mean position. Also called *target glint* or *wander.*

This includes but is not limited to shift of effective reflection point on the target.

scintillation counter. The combination of **phosphor, photomultiplier** tube, and associated circuits for counting **scintillations,** sense **2.** Also called *scintillating counter.*

scintillation meter = scintillometer.

scintillometer. A type of photoelectric **photometer** used in a method of determining high-altitude winds on the assumption that stellar **scintillation** is caused by atmospheric inhomogeneities (**schlieren**) being carried along by the wind near **tropopause** level. Also called *scintillation meter.*

Scl, Scul. International Astronomical Union abbreviations for *Sculptor.* See **constellation.**

Sco, Scor. International Astronomical Union abbreviations for *Scorpius.* See **constellation.**

scope. The general abbreviation for an instrument of viewing, such as telescope, microscope, and oscilloscope. In radar installations, the **cathode-ray oscilloscope** indicators are commonly referred to as *scopes* or *radarscopes.*

Because of possible ambiguity this term should be avoided in formal reports.

Scor. International Astronomical Union abbreviation for *Scorpius.* See **constellation.**

Scorpius (*abbr* **Sco, Scor**). See **constellation.**

scotopic vision. Vision associated with levels of illumination below approximately 0.01 footlambert, effective primarily in the detection of movement and low luminous intensities. Compare **photopic vision.** Also called *parafoveal vision.*

Scotopic vision is associated with **rod** function.

screaming. A form of **combustion instability,** especially in a **liquid-propellant rocket engine,** of relatively high frequency and characterized by a high-pitched noise.

screeching. A form of **combustion instability,** especially in an **afterburner,** of relatively high frequency and characterized by a harsh, shrill noise.

screen. 1. A device to shield or separate one part of an apparatus from other parts, or to separate the effects of one part on others. **2.** A surface on which images are displayed, as the face of a **cathode-ray tube.**

scrub. To cancel a scheduled firing, either before or during **countdown.**

Sct, Scut. International Astronomical Union abbreviations for *Scutum.* See **constellation.**

Scul. International Astronomical Union abbreviation for *Sculptor.* See **constellation.**

Sculptor (*abbr* **Scl, Scul**). See **constellation.**

Scutum (*abbr* **Sct, Scut**). See **constellation.**

sea clutter. See **ground return.**

sealed cabin. The occupied space of an aircraft or **spacecraft** characterized by walls which do no allow any gaseous exchange between the inner atmosphere and its surrounding atmosphere and containing its own mechanisms for maintenance of the inside atmosphere.

sea level = mean sea level.

sea-level pressure. The **atmospheric pressure** at **mean sea level,** either directly measured or, most commonly, empirically determined from the observed station pressure.

searchlighting. **Horizontal scanning,** in which the antenna beam is continuously rotated in **azimuth.**

search radar. A **radar** designed for the approximate location of (usually airborne) objects. Search radar beams are usually wide, wider in the vertical than in the horizontal, making it possible to scan large volumes of space quickly. Compare **tracking radar.**

sea return. See **ground return.**

seat belt = lap belt.

seat-to-head acceleration. See **physiological acceleration.**

second (*abbr* **s**). See **ephemeris second.**

secondary. **1.** = **secondary great circle.** **2.** A celestial body revolving around another body, its **primary.** **3.** A particle emitted in **secondary emission.**

secondary circle = secondary great circle.

secondary cosmic radiation = secondary cosmic rays.

secondary cosmic rays. Secondary **emission** in the **atmosphere** stimulated by **primary cosmic rays.** See **air shower.**

secondary electron emission. The release of **electrons** from a surface which is bombarded by energetic electrons.

The yield or ratio of secondary to primary electrons is a function of the primary electron energy.

secondary emission. Emission of **subatomic particles** or **photons** stimulated by primary radiation; for example, cosmic rays impinging on other particles and causing them, by disruption of their electron configurations or even of their nuclei, to emit particles and photons or both in turn.

secondary great circle. A **great circle** perpendicular to a **primary great circle,** as a **meridian.** Also called *secondary circle, secondary.*

secondary instrument. An instrument whose calibration is determined by comparison with an **absolute instrument.**

secondary radar. See **radar,** note.

secondary radiation. **Electromagnetic** or particulate **radiation** resulting from absorption of other radiation in matter.

secondary scattering. See **multiple scattering, scattering.**

second law of thermodynamics. An inequality asserting that it is impossible to transfer **heat** from a colder to a warmer system without the occurrence of other simultaneous changes in the two **systems** or in the **environment.**

It follows from this law that during an adiabatic process, entropy cannot decrease. For reversible adiabatic processes entropy remains constant, and for irreversible adiabatic processes it increases.

Another equivalent formulation of the law is that it is impossible to convert the heat of a system into work without the occurrence of other simultaneous changes in the system or its environment. This version, which requires an engine to have a cold source as well as a heat source, is particularly useful in engineering applications. See **first law of thermodynamics.**

Secor (*abbr*) = **sequential collation of range.**

Secor/DME. (*Se*quential *co*llation *o*f *r*ange/ *d*istance *m*easuring *e*quipment). A distance-measuring system used in **rocket** tracking.

section. One of the cross-section parts that a **rocket vehicle** is divided into, each adjoining another at one or both of its ends. Usually described by a designating word, as in *nose section, aft section, center section, tail section, thrust section, tank section,* etc.

sectionalized vertical antenna. A vertical **antenna** which is insulated at one or more points along its length. The insertion of suitable reactances or applications of a driving voltage across the insulated points results in a modified current distribution giving a more desired **radiation pattern** in the vertical plane.

sector scanning. See **scanning.**

secular. Pertaining to long periods of time on the order of a century, as *secular perturbations, secular terms.*

secular perturbations. Changes in the **orbit** of a planet or satellite that operate in extremely long cycles; long term **perturbations.**

secular terms. In the mathematical expression of an orbit, terms for very long period **pertur-**

bations, in contrast to *periodic terms*, terms of short period.

Seebeck effect. The establishment of an electric potential difference tending to produce a flow of current in a circuit of two dissimilar metals the junctions of which are at different temperatures.

seeding. **1.** The introduction of atoms, such as sodium, with a low **ionization potential** into a hot gas for the purpose of increasing the electrical conductivity. **2.** = **cloud seeding.**

seeing. A blanket term long used by astronomers for the disturbing effects produced by the **atmosphere** upon the image quality of an observed celestial body. Also called *astronomical seeing.*

Recent studies show that *seeing* is a combination of three principal and distinct effects that the human eye is not capable of distinguishing: (a) scintillation, i.e., fluctuations in brightness; (b) transverse displacements of the image; and (c) variations of the radius of curvature of the wavefront rendering the image in and out of focus.

seismic mass. The element in an **accelerometer** which is intended to serve as the force-summing member for applied accelerations, gravitational forces, or both.

selective absorption. **Absorption** which varies with the wavelength of radiation incident upon the absorbing substance. See **absorption spectrum.**

A substance which absorbs in such fashion is called a *selective absorber* and is to be contrasted with an ideal black body, white body, or gray body. In reality, all substances are selective absorbers when due regard is paid to their interaction with all wavelengths of the complete electromagnetic spectrum.

selective scattering. **Scattering** which varies with the **wavelength** of radiation incident upon the scattering particles.

In general, the largest and most complex degree of selectivity is found for wavelengths nearly equal to the diameter of the scattering particles.

selectivity. The degree of falling off in response of a resonant device with departure from **resonance.**

selenocentric. Relating to the center of the moon; referring to the moon as a center.

selenographic. **1.** Of or pertaining to the physical geography of the moon. **2.** Specifically, referring to positions on the moon measured in **latitude** from the moon's **equator** and in **longitude** from a **reference meridian.**

selenoid. A **satellite** of the earth's moon. (No such satellites are known.)

selenology. That branch of astronomy that treats of the moon, its magnitude, motion, constitution, and the like. *Selene* is Greek for *moon.*

self-adaptive control system. A particular type of stability augmentation system which changes the response of a given **control** input by constantly sampling response and adjusting its **gain,** rather than having a fixed or selective gain system.

self-balancing potentiometer. See **potentiometer.**

self-excited vibration = **self-induced vibration.**

self-induced vibration. **Vibration** of a mechanical **system** resulting from conversion, within the system, of nonoscillatory excitation to oscillatory excitation. Also called *self-excited vibration.*

self-information = **information content.**

selsyn. (A trade name, from *self-syn*chronous; often capitalized.) An electrical remote-indicating instrument operating on direct current, in which the angular position of the transmitter shaft, carrying a contact arm moving on a resistance strip, controls the pointer on the **indicator** dial.

semiactive homing guidance. **Guidance** in which a craft or vehicle is directed toward a destination by means of information received from the destination in response to transmissions from a source other than the craft.

In active homing guidance the information received is in response to transmissions from the craft. In passive homing guidance natural radiations from the destination are utilized.

semiactive tracking system. A **trajectory measuring system** which tracks a signal source normally aboard the target for other purposes, or a system that illuminates the target by use of a ground transmitter but requires no special electronics on board the missile, e.g., **telemetry elsse, Dovap elsse, Cotat, Cotar, VHF/ADF, pulse radar** (skin track).

semicircular canals. Structures of the **inner ear,** the primary function of which is to register movement of the body in space. They respond to change in the rate of movement.

semiconductor. An electronic **conductor,** with **resistivity** in the range between metals and insulators, in which the electrical charge carrier concentration increases with increasing temperature over some temperature range. Certain semiconductors possess two types of **carriers,** namely, negative **electrons** and positive **holes.**

semiconductor device. An **electron device** in which the characteristic distinguishing electronic conduction takes place within a **semiconductor.**

semidiameter. **1.** The radius of a closed figure. **2.** Half the angle at the observer subtended by the visible disk of a **celestial body.**

semidiameter correction. A correction due to **semidiameter,** particularly that sextant altitude correction resulting from observation of the upper or lower **limb** of a celestial body, rather than the center of that body.

semidiurnal. Having a period of, occurring in, or related to approximately half a day.

semimajor axis (*symbol* a). One-half the longest diameter of an **ellipse.**

semiminor axis (*symbol* b). One-half the shortest diameter of an **ellipse.**

semimonocoque. A structural concept in which longitudinal members as well as **formers** reinforce the skin and help carry the stresses. Compare with **monocoque.**

semitransparent photocathode. A **photocathode** in which **radiant flux** incident on one side produces **photoelectric emission** from the opposite side. See **phototube.**

sensation level. The level of psychophysiologic stimulation above the **threshold.**

sense antenna. An antenna used to resolve a 180° **ambiguity** in a **directional antenna.**

sense-reversing reflectivity. The characteristic of a **reflector** that reverses the sense of a circularly polarized incident ray. See **polarization.**

For example, a perfect corner reflector is invisible to a circularly polarized radar because it reverses the sense.

sensibility. In measurements, the smallest change that is reliably detectable.

sensible atmosphere. That part of the **atmosphere** that offers resistance to a body passing through it.

sensible horizon. See **horizon,** note.

sensible temperature. The temperature at which average indoor air of moderate **humidity** would induce, in a lightly clothed person, the same sensation of comfort as that induced by the actual environment. Compare **effective temperature.**

Sensible temperature depends on the air temperature; radiation from the sun, sky, and surrounding objects; relative humidity; and air motion. The wet-bulb temperature is often taken as an approximate measure.

sensing element = sensor.

sensitivity. **1.** The ability of electronic equipment to amplify a **signal,** measured by the minimum strength of signal **input** capable of causing a desired value of **output.** The lower the input signal for a given output, the higher the sensitivity. **2.** In measurements, the derivative representing the change in instrument indication produced by a change in the variable being measured.

sensitometry. The measurement of the light response characteristics of photographic film under specified conditions of exposure and development.

sensor. **1.** The component of an instrument that converts an **input** signal into a quantity which is measured by another part of the instrument. Also called *sensing element.* **2.** The nerve endings or sense organs which receive information from the environment, from the organism, or from both.

separation. **1.** The action of a **fallaway section** or **companion body** as it casts off from the remaining body of a **vehicle,** or the action of the remaining body as it leaves a fallaway section behind it. **2.** The moment of this action.

separation velocity. The velocity at which a space **vehicle** is moving when some part or section is separated from it; specifically, the velocity of a space probe or satellite at the time of separation from the **launch vehicle.**

September equinox = autumnal equinox.

sequencer. A mechanical or electronic device that may be set to initiate a series of events and to make the events follow in a given sequence. See **program.**

sequential collation of range (*abbr* **Secor**). A spherical, long-baseline, phase-comparison **trajectory-measuring system** utilizing three or more ground stations, time sharing a single **transponder,** to provide nonambiguous range measurements to determine the instantaneous position of a vehicle in flight.

sequential control. **Control** by completion of a series of one or more events.

Ser, Serp. International Astronomical Union abbreviations for *Serpens* (*Cap. and Caud.*). See **constellation.**

Serpens (Cap. and **Caud.)** (*abbr* **Ser, Serp**). See **constellation.**

servo. **1. = servomechanism.** **2.** Pertaining to or incorporating a servomechanism.

servomechanism. A **control** system incorporating **feedback** in which one or more of the system signals represent mechanical motion.

It should be noted that *servomechanism* and *regulator* are not mutually exclusive terms; their application to a particular system will depend on the method of operation of that system.

set. **1.** To place a **storage** device in a prescribed state. **2.** To place a **binary cell** in the *one* state.

Sex, Sext. International Astronomical Union abbreviations for *Sextans.* See **constellation.**

sexidecimal notation. A **positional notation** based on the integer *sixteen.*

Sext. International Astronomical Union abbreviation for *Sextans.* See **constellation.**

Sextans (*abbr* **Sex, Sext**). See **constellation.**

sextant. A double-reflecting instrument for measuring angles, primarily **altitudes** of **celestial bodies.**

As originally used, the term applied only to instruments having an arc of 60°, a sixth of a circle, from which the instrument derived its name. Such an instrument had a range of 120°. In modern practice the term applies to a similar instrument, regardless of its range, very few modern instruments being sextants in the original sense.

sextant altitude. The **altitude** of a **celestial body** as actually measured by a **sextant.** See **altitude difference.**

sferics. 1. (Also spelled *spherics*). The study of **atmospherics,** especially from a meteorological point of view. This involves techniques of locating and tracking atmospherics sources and evaluating received signals (waveform, frequency, etc.) in terms of source. **2.** = **atmospherics.**

sferics fix. The estimated location of a source of **atmospherics,** presumably a lightning discharge.

sferics observation. An evaluation, from one or more **sferics receivers,** of the location of weather conditions with which lightning is associated.

Such observations are more commonly obtained from networks of two or three widely spaced stations. Simultaneous observations of the azimuth of the discharge are made at all stations and the location of the storm is determined by triangulation.

sferics receiver. An instrument which measures, electronically, the direction of arrival, intensity, and rate of occurrence of **atmospherics.** In its simplest form the instrument consists of two orthogonally crossed antennas. Their output signals are connected to an oscillograph so that one loop measures the north-south component whereas the other measures the east-west component. These are combined vertically to give the azimuth. Also called **lightning recorder.**

Sge, Sgte. International Astronomical Union abbreviations for *Sagitta.* See **constellation.**

Sgr, Sgtr. International Astronomical Union abbreviations for *Sagittarius.* See **constellation.**

Sgte. International Astronomical Union abbreviation for *Sagitta.* See **constellation.**

Sgtr. International Astronomical Union abbreviation for *Sagittarius.* See **constellation.**

shadow. Darkness in a region, caused by an obstruction between the source of light and the region.

By extension, the term is applied to a similar condition when any form of radiant energy is cut off by an obstruction, as a *radar shadow.* The darkest part of a shadow in which light is completely cut off is called the *umbra*; a lighter part surrounding the umbra, in which the light is only partly cut off, is called the *penumbra.*

shadowgraph. 1. A picture or image in which steep density **gradients** in the flow about a body are made visible, the body itself being presented in silhouette. **2.** The optical method or technique by which this is done.

A shadowgraph differs from a **schlieren photograph** in that the schlieren method depends on the first derivative of the refractive index while the shadow method depends on the second derivative. Interference measurements give the refractive index directly.

shadow shield. A **shield** that is interposed between a **radiation** source and a specific area to be protected.

Useful in space, a shadow shield is less effective in the earth's atmosphere because air scattering deflects radiation around it.

shaker. An electromagnetic device capable of imparting known **vibratory acceleration** to a given object.

shake-table test. A laboratory test for **vibration** tolerance, in which the device to be tested is placed in a vibrator.

shaped-beam antenna. A **unidirectional antenna** whose major **lobe** differs materially from that obtainable from an aperture of uniform phase. Also called *phase-shaped antenna.*

shear strength. In materials, the **stress** required to produce fracture in the plane of cross section, the conditions of loading being such that the directions of force and of resistance are parallel and opposite although their paths are offset a specified minimum amount.

shear wave. A **wave** in an elastic medium which causes an element of the medium to change its shape without a change of volume. Mathematically, a shear wave is one whose velocity field has zero divergence. Also called *rotational wave.*

A shear plane wave in an isotropic medium is called a *transverse wave.*

sheath = **plasma sheath.**

shell. A body one of whose dimensions is small compared with the others.

shield. A body of material used to prevent or reduce the passage of **particles** or **radiation.**

A shield may be designated according to what it is intended to absorb, as a *gamma-ray shield* or *neutron shield*, or according to the kind of protection it is intended to give, as a *background, biological,* or *thermal shield.* The shield of a nuclear reactor is a body of material designed to prevent the escape of neutrons and radiation into a protected area, which frequently is the entire space external to the reactor. It may be required

for the safety of personnel or to reduce radiation sufficiently to allow use of counting instruments.

shielding. The arrangement of **shields** used for any particular circumstances; the use of shields.

shimmer = **terrestrial scintillation.**

shock. 1. = **shock wave. 2.** A blow, impact, collision, or violent jar. **3.** A sudden agitation of the mental or emotional state or an event causing it. **4.** The sudden stimulation caused by an electrical discharge on the animal or human organism (e.g., electric shock).

shock absorber. A device for the dissipation of energy used to modify the response of a mechanical system to applied **shock.**

shock front. 1. A **shock wave** regarded as the forward surface of a **fluid** region having characteristics different from those of the region ahead of the wave. **2.** The front side of a shock wave.

shock isolator. A resilient support that tends to isolate a system from applied **shock.** Also called *shock mount.*

shock mount = **shock isolator.**

shock spectrum. A plot of the maximum **acceleration** experienced by a **single-degree-of-freedom** system as a function of its own **natural frequency** in response to an applied **shock.**

shock tube. A relatively long tube or pipe in which very brief high-speed gas flows are produced by the sudden release of gas at very high pressure into a low-pressure portion of the tube; the high-speed flow moves into the region of low pressure behind a shock wave.

shock tunnel. A **shock tube** used as a **wind tunnel.**

shock wave. A surface or sheet of discontinuity (i.e., of abrupt changes in conditions) set up in a **supersonic** field of **flow,** through which the **fluid** undergoes a finite decrease in velocity accompanied by a marked increase in pressure, density, temperature, and entropy, as occurs, e.g., in a supersonic flow about a body. Sometimes called a *shock.* See **attached shock wave, bow wave, condensation shock wave, detached shock wave, Mach wave, normal shock wave, oblique shock wave.**

Shodop (*abbr*) = ***short-range Doppler.***

shooting star = **meteor.**

shoran. (From *sho*rt-*ra*nge *n*avigation.) A precision electronic **position** fixing system using a **pulse** transmitter and receiver and two **transponder** beacons at fixed points.

High-precision shoran is called *hiran.*

short-baseline system. A **trajectory measuring system** using a **baseline** the length of which is very small compared with the distance of the object being tracked.

short-period error = **random error.**

short-range Doppler (*abbr* **Shodop**). A short-range **trajectory measuring system** using the intersections of the ellipsoids of **Dovap** and the hyperboloids of **Dovap elsse** or **telemetry elsse** during a rocket **launch.**

short-range navigation = **shoran.**

short-wave radiation. In meteorology, a term used loosely to distinguish radiation in the visible and near-visible portions of the **electromagnetic spectrum** (roughly 0.4 to 1.0 micron in wavelength) from long-wave radiation (**infrared radiation**).

shot. 1. An act or instance of firing a **rocket,** especially from the earth's surface, as, *the shot carried the rocket 200 miles.* **2.** The flight of a rocket, as, *the rocket made a 200-mile shot.*

shoulder harness. A harness that fastens over a person's shoulders to prevent his being thrown forward in his seat. See **lap belt.**

shower = **air shower** (cosmic rays).

shutdown. The process of decreasing engine **thrust** to zero.

shutoff = **fuel shutoff.**

SI (*abbr*) = **International System of Units.**

SID (*abbr*) = **sudden *i*onospheric *d*isturbance.**

sideband. 1. Either of the two **frequency bands** on both sides of the **carrier** frequency within which fall the frequencies of the wave produced by the process of **modulation. 2.** The wave components lying within such a band.

side lobe. See **lobe.**

sidereal. Of or pertaining to the stars.

Although *sidereal* generally refers to the stars and *tropical* to the vernal equinox, sidereal time and the sidereal day are based upon the position of the vernal equinox relative to the meridian. The sidereal year is based upon the stars.

sidereal day. The duration of one **rotation** of the earth on its axis, with respect to the **vernal equinox.** It is measured by successive transits of the vernal equinox over the **upper branch** of a **meridian.**

Because of the precession of the equinoxes, the sidereal day thus defined is slightly less than the period of rotation with respect to the stars, but the difference is less than 0.01 second. The length of the mean sidereal day is 24 hours of sidereal time or 23 hours 56 minutes 4.09054 seconds of mean solar time.

sidereal hour angle (*abbr* **SHA**). Angular distance west of the **vernal equinox;** the arc of

the **celestial equator,** or the angle at the celestial pole, between the **hour circle** of the vernal equinox and the hour circle of a point on the **celestial sphere,** measured westward from the hour circle of the vernal equinox through 360°.

Angular distance east of the vernal equinox, through 24 hours, is *right ascension.*

sidereal month. The average **period** of **revolution** of the moon with respect to the stars, a period of 27 days 7 hours 43 minutes 11.5 seconds, or approximately $27\frac{1}{3}$ days.

sidereal period. 1. The time taken by a **planet** or **satellite** to complete one **revolution** about its **primary** as seen from the primary and as referred to a fixed star. **2.** Specifically, the interval between two successive returns of an earth satellite in orbit to the same geocentric **right ascension.**

sidereal time. Time based upon the **rotation** of the earth relative to the **vernal equinox.**

Sidereal time may be designated as *local* or *Greenwich* as the local or Greenwich meridian is used as the reference. When adjusted for nutation, to eliminate slight irregularities in the rate, it is called *mean sidereal time.*

sidereal year. The period of one apparent **revolution** of the earth around the sun, with respect to the stars, averaging 365 days 6 hours 9 minutes 9.55 seconds in 1955, and increasing at the rate of 0.000095 second annually.

Because of the precession of the equinoxes this is about 20 minutes longer than a tropical year.

sight = celestial observation.

sigma = standard deviation.

signal. 1. A visible, audible, or other, indication used to convey **information. 2.** The information to be conveyed over a communication system. **3.** Any carrier of information; opposed to **noise.**

signal strength. In radio, a measure of the received radiofrequency **power,** generally expressed in decibels relative to some standard value, normally either 1 milliwatt or that power which would have resulted at the same distance under free-space transmission. Also called *field strength.*

signal-to-noise ratio (*abbr* **SNR** or **S/N**). A ratio which measures the comprehensibility of a data source or transmission link, usually expressed as the root-mean-square **signal** amplitude divided by the root-mean-square **noise** amplitude.

The higher the S/N ratio, the less the interference with reception.

signal transmission level. In a transmission system, the signal **level,** of a kind to be specified, at a designated position in the system.

The signal level at some specified position near the source may be taken as the zero reference level.

In an acoustic system the signal level is often in the form of a sound pressure level; either the reference sound pressure or the reference sound pressure level must be specified.

signal velocity. See **velocity of propagation,** note.

signs. See **zodiac.**

silver-cell battery. A type of short-duration, high-power-density **battery** of light weight used for single-time, high-power applications in vehicles where weight is critical.

silver-disk pyrheliometer. An instrument used for the measurement of **direct solar radiation.** See **pyrheliometer.**

It is constructed in the following manner. A silver disk located at the lower end of a diaphragmed tube serves as the radiation receiver for a calorimeter. Radiation falling on the silver disk is periodically intercepted by means of a shutter located in the tube, causing temperature fluctuations of the calorimeter which are proportional to the intensity of the radiation.

The instrument is normally used as a secondary instrument and is calibrated against the water-flow pyrheliometer. It is used by the U.S. Weather Bureau as a standard instrument.

simple average. See **arithmetic mean,** sense **2.**

simple harmonic motion. A motion such that the **displacement** is a **sinusoidal** function of time.

simple harmonic quantity. A **periodic** quantity that is a **sinusoidal** function of the **independent variable.** Thus,

$$y = A \sin (\omega x + \varphi)$$

where y is the simple harmonic quantity; A is the amplitude; ω is the angular frequency; x is the independent variable; and φ is the phase of the oscillation.

The maximum value of the simple harmonic quantity is the amplitude A; it is sometimes called, for emphasis, the *single amplitude* to distinguish it from *double amplitude* which for a simple harmonic quantity is the same as the total excursion or peak-to-peak value.

When a simple harmonic quantity is expressed as a complex quantity, the term *amplitude* must be used with caution in view of possible confusion with the alternate meaning of *amplitude* as the angle or argument of a complex quantity.

simple reflection = specular reflection.

simple reflector = specular reflector.

simple standard deviation. See **standard deviation.**

sine wave. A **wave** which can be expressed as the sine of a linear function of time, or space, or both.

single-degree-of-freedom system. A mechanical **system** for which only one **coordinate is**

required to define completely the configuration of the system at any instant. See **degree of freedom.**

single-entry compressor. A **centrifugal compressor** that takes in air or fluid on only one side of the **impeller,** the impeller being faced with vanes only on that side.

single sheath. See **plasma sheath,** note.

single-sideband modulation. Modulation whereby the spectrum of the modulating wave is translated in **frequency** by a specified amount either with or without inversion.

single-sideband transmission. That method of operation in which one **sideband** is transmitted and the other sideband is suppressed. The **carrier wave** may be either transmitted or suppressed.

single-stage compressor. A **centrifugal compressor** having a single **impeller** wheel, with vanes either on one or on both sides of the wheel; also, an **axial-flow compressor** with one row of **rotor** blades and one row of **stator** blades. Axial-flow compressors are normally multistage.

single-stage rocket. A **rocket vehicle** provided with a single rocket propulsion system. See **stage.**

single-stage turbine. A turbine having one set of **stator** blades followed by a set of **rotor** blades.

sink. **1.** In the mathematical representation of fluid **flow,** a hypothetical point or place at which the fluid is absorbed. **2.** A **heat sink.** See **source.**

sinking. In atmospheric optics, a **refraction** phenomenon, the opposite of **looming,** in which an object on or slightly above the geographic horizon apparently sinks below it. Compare **inferior mirage, stooping.**

Sinking occurs whenever the rate of density decreases with height through the atmosphere is of smaller magnitude than normal or, in extreme cases, where the density actually increases with height.

sintered ceramic. A **ceramic** body or coating prepared by heating a ceramic powder below its melting point but at a sufficiently high temperature to cause interdiffusion of ions between contacting particles and subsequent adherence at the points of contact.

sintering. The **bonding** of adjacent surfaces of particles in a mass of powders, usually metal, by heating.

sinus. A hollow or cavity; a recess or pocket. Specifically, sinuses: air cavities lined by mucous membrane which communicate with the nasal cavity; the ethmoidal, frontal, sphenoidal, and maxillary sinuses.

sinus barotrauma = aerosinusitis.

sinusoidal. Having the form of a sine wave.

skiatron. **1.** A dark trace oscilloscope tube. See **dark trace tube.** **2.** A **display** employing an optical system with a dark trace tube.

skimmer basin = deluge collection pond.

skin. The covering of a body, of whatever material, such as the covering of a fuselage, of a wing, of a hull, of an entire aircraft, etc.; a body shell, as of a rocket; the surface of a body.

skin temperature. The outer surface **temperature** of a body.

skin tracking. The **tracking** of an object by means of **radar** without using a **beacon** or other signal device on board the object being tracked.

skip effect. A phenomenon in which **sound** or **radio energy** may be detected only at various distance intervals from the energy source as the result of the presence of an energy reflecting or refracting layer in the atmosphere. See **radio duct.**

For long radio waves, the ionosphere acts as the reflecting layer. For shorter wavelengths, the effect may be produced by strong superstandard propagation in elevated layers of the troposphere. Skip effects make it possible on occasion to detect targets at distances far greater than the normal radio horizon, while closer targets remain undetected.

skirt. The lower outer part of a **rocket vehicle;** specifically, the half-stage of an Atlas.

skirt fog. The cloud of steam and water that surrounds the engines of a **rocket** being launched from a **wet emplacement.**

skyhook balloon. (Originally a code name for a U.S. Navy project.) A large free balloon having a plastic envelope, used especially for constant-level meteorological observations at very high altitudes.

sky light = diffuse sky radiation.

sky radiation = diffuse sky radiation.

sky screen. An optical device used to detect the departure of a **rocket** from its intended **trajectory.**

sky wave. In radio, **radio energy** that is received after having been reflected by the **ionosphere.** Compare **wave.**

slant range. The **line-of-sight** range of a radar or radio. See **range.**

slave. **1. = slave station.** **2.** Device that follows an order given by a **master** through remote control.

slave antenna. A **directional antenna** that is positioned in azimuth and elevation by a **servosystem.** The information controlling

SNAP= Selective niobium anodization process

Sneak Circuit. A latent path which causes an unwanted function to occur or inhibits a desired function without regard to component failure.

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the servosystem is supplied by a **tracking** or positioning system.

slave station. In a hyperbolic navigation system, a station whose transmissions are controlled by a **master station.** Often shortened to *slave*. See **hyperbolic navigation.**

slaving. Of a **gyro,** the use of a **torquer** to maintain the orientation of the **spin axis** relative to an external reference such as a pendulum or magnetic compass.

sleeve-dipole antenna. A **dipole antenna** surrounded in its central portion by a coaxial sleeve.

slenderness ratio. A dimensionless number expressing the ratio of a **rocket vehicle** length to its diameter.

slew. To change the position of an **antenna** or range gear assembly by injecting a synthetic error signal into the positioning **servoamplifier.**

slewing. 1. Of a **gyro,** the rotation of the **spin axis** caused by applying **torque** about the axis of rotation. **2.** In **radar,** changing the scale on the **display.**

slip. A sprayable **slurry** comprising a **frit** suspended in a liquid carrier (sometimes also used for dip and brush coating).

slip flow. See **rarefied gas dynamics,** note.

slope angle. The angle in the vertical plane between the **flightpath** and the **horizontal.**

sloshing. The back-and-forth movement of a **liquid** fuel in its tank, creating problems of stability and control in the **vehicle.**

slow ion = large ion.

slug. A unit of **mass;** the mass of a free body which if acted upon by a force of 1 pound would experience an acceleration of 1 foot per square second; thus approximately 32.17 pounds.

slurry. A **suspension** of fine solid particles in a liquid.

slurry fuel. A **fuel** consisting of a **suspension** of fine solid particles in a liquid.

small calorie (*abbr* **cal**). See **calorie.**

small circle. The intersection of a sphere and a plane which does not pass through the center of the sphere, as a **parallel** of latitude.

small ion. An atmospheric **ion,** apparently a singly charged atmospheric molecule (or, rarely, an atom) about which a few other neutral molecules are held by the electrical attraction of the central ionized molecule. Estimates of the number of satellite molecules range as high as 12. Also called *light ion, fast ion.*

Small ions may disappear either by direct recombination with oppositely charged **small ions** or by combination with neutral **Aitken nuclei** to form new large ions, or by combination with large ions of opposite sign. The small ion, collectively, is the principal agent of atmospheric conduction.

small perturbation. A disturbance imposed on a system in steady state, with amplitude assumed small, i.e., the square of the amplitude is negligible in comparison with the amplitude, and the derivatives of the perturbation are assumed to be of the same order of magnitude as the perturbation. See **perturbation, method of small perturbations.**

Snell law. See **refraction, index of refraction.**

Snort track. A rail track on which a **supersonic** rocket sled is driven, located at the Naval Ordnance Test Station.

snow = grass.

snubber. A device used to increase the stiffness of an elastic system, usually by a large factor, whenever the **displacement** becomes larger than a specified amount.

sofar. (From *so*und *f*ixing *a*nd *r*anging.) A system of navigation providing hyperbolic **lines of position** determined by shore listening stations which receive sound signals produced by depth charges dropped at sea and exploding in a sound channel which is at a considerable depth in most areas.

This system is used in Project Mercury for locating spacecraft down at sea.

softening range. An arbitrarily defined temperature range below the crystal melting point where a **ceramic** becomes soft and noticeably viscous; a softening range rather than a sharp melting point occurs in ceramics containing a glass base.

soft landing. The act of landing on the surface of a **planet** without damage to any portion of the vehicle or payload except possibly the landing gear.

soft radiation. Radiation absorbable by an absorber equivalent to 10 centimeters of lead or less.

Radiation which can penetrate more than 10 centimeters of lead is termed *hard radiation.*

solar. 1. Of or pertaining to the sun or caused by the sun, as *solar radiation, solar atmospheric tide.* **2.** Relative to the sun as a *datum* or *reference,* as *solar time.*

solar activity. Any type of variation in the appearance or energy output of the sun. See **faculae, flare, flocculi, granules, prominence, spicules, sunspot.**

solar air mass. The **optical air mass** penetrated by light from the sun for any given position of the sun in the sky.

solar antapex. See **solar apex.**

solar apex. The point on the **celestial sphere** toward which the sun is traveling. Also called *apex of the sun's way.*

The solar apex is at approximately right ascension 270° declination 34° N. The point diametrically opposite the solar apex on the celestial sphere is the solar antapex, right ascension 90° declination 34° S.

solar atmospheric tide. An **atmospheric tide** due to the thermal or gravitational action of the sun.

Six- and eight-hour components of small amplitude have been observed. They are primarily thermal in origin. The 12-hour component has by many times the greatest amplitude of any atmospheric tidal component, about 1.5 millibars at the equator and 0.5 millibar in middle latitudes. This relatively large amplitude is often explained as a resonance effect. The 24-hour component is a thermal tide with great local variability.

solar cell. A **photovoltaic cell** that converts sunlight into electrical energy.

solar constant. The rate at which **solar radiation** is received outside the earth's atmosphere on a surface normal to the incident radiation and at the earth's mean distance from the sun.

Measurements of solar radiation at the earth's surface by the Smithsonian Institution for several decades give a best value for the solar constant of 1.934 calories per square centimeter per minute. Measurements from rockets of the intensity of the ultraviolet end of the spectrum have corrected this value to 2.00 calories per square centimeter per minute with a probable error of ± 2 percent.

solar corona. See **corona.**

solar corpuscular rays. Cosmic radiation supposedly originating in the sun. See **corpuscular cosmic rays.**

solar cosmic rays. Cosmic rays supposedly originating in the sun.

solar cycle. The periodic increase and decrease in the number of **sunspots.** The cycle has a period of about 11 years.

solar day. 1. The duration of one **rotation** of the earth on its axis, with respect to the sun.

This may be either a *mean solar day,* or an *apparent solar day,* as the reference is the mean or apparent sun, respectively.

2. The duration of one **rotation** of the sun on its axis.

solar eclipse. The obscuration of the light of the sun by the moon.

A solar eclipse is *partial* if the sun is partly obscured, *total* if the entire surface is obscured, or *annular* if a thin ring of the sun's surface appears around the obscuring body.

solar flare. See **flare.**

solarimeter. 1. = pyranometer. 2. Specifically, a pyranometer consisting of a **Moll thermopile** covered by a bell glass.

solar parallax. The angle at the sun subtended by the equatorial diameter of the earth. See **parallax.**

The adopted value of the solar parallax in the system of astronomical constants is 8.80 seconds of arc.

solar prominence = prominence.

solar protons. Protons emitted by the sun, especially during solar **flares.**

solar radiation. The total **electromagnetic radiation** emitted by the sun. See **insolation, direct solar radiation, diffuse sky radiation, global radiation, extraterrestrial radiation, solar constant.**

To a first approximation, the sun radiates as a black body at a temperature of about 5700° K; hence about 99.9 percent of its energy output falls within the wavelength interval from 0.15 micron to 4.0 microns, with peak intensity near 0.47 micron. About one-half of the total energy in the solar beam is contained within the visible spectrum from 0.4 to 0.7 micron, and most of the other half lies in the near infrared, a small additional portion lying in the ultraviolet.

solar-radiation observation. An evaluation of the radiation from the sun that reaches the observation point. The observing instrument is usually a **pyrheliometer** or **pyranometer.**

Two types of such observations are taken. The more common consists of measurements of the radiation reaching a horizontal surface, consisting of both radiation from the sun (direct solar radiation) and that reaching the instrument indirectly by scattering in the atmosphere (diffuse sky radiation). The other type of observation involves the use of an equatorial mount that keeps the instrument pointed directly at the sun at all times. The sensitive surface of the instrument is normal to the path of the radiation and is shielded from indirect radiation from the sky.

solar radio burst. A sudden increase in the **flux** from the sun at **radio frequencies.**

solar radio waves. Radiation at **radio frequencies** originating in the sun or its **corona.**

solar simulator. A device which produces thermal energy, equivalent in intensity and spectral distribution to that from the sun, used in testing materials and space vehicles.

solar system. The sun and other celestial bodies within its gravitational influence, including **planets, asteroids, satellites, comets,** and **meteors.**

solar tide. See **solar atmospheric tide.**

solar time. Time based upon the **rotation** of the earth relative to the sun.

Solar time may be designated as *mean* or *astronomical* if the mean sun is the reference, or *apparent* if the apparent sun is the reference. The difference between mean and apparent time is called *equation of time.* Solar time may be further designated according to the reference meridian, either the *local* or *Greenwich* meridian or additionally in the case of mean time, a designated zone meridian. Standard or daylight-saving are variations of zone time. Time may also be designated according to the timepiece, as *chronometer time* or *watch time,* the time indicated by these instruments.

solar wind. Streams of **plasma** flowing approximately radially outward from the sun.

solar year = **tropical year.**

solenoid. A tube formed in space by the intersection of unit-interval **isotimic** surfaces of two scalar quantities.

Solenoids formed by the intersection of surfaces of equal pressure and density are frequently referred to in meteorology. A barotropic atmosphere implies the absence of solenoids of this type, since surfaces of equal pressure and density coincide.

solid angle (*symbol* ω). A portion of the whole of space about a given point, bounded by a conical surface with its vertex at that point and measured by the area cut by the bounding surface from the surface of a sphere of unit radius centered at that point. See **steradian.**

solid propellant. Specifically, a **rocket propellant** in solid form, usually containing both fuel and oxidizer combined or mixed, and formed into a monolithic (not powdered or granulated) **grain.**

solid-propellant engine = **solid-propellant rocket engine.**

solid-propellant rocket engine. A **rocket engine** fueled with a **solid propellant.** Such motors consist essentially of a **combustion chamber** containing the propellant, and a **nozzle** for the exhaust jet, although they often contain other components, as grids, liners, etc.

solid rocket. A rocket that uses a **solid propellant.**

solid rocket fuel. A **solid propellant.**

solid rotation. The **rotation** of a system as though it were a solid or rigid body rotating about a fixed axis, all points within the body having the same **angular velocity.**

solid-state devices. Devices which utilize the electric, magnetic, and photic properties of solid materials, e.g., binary magnetic cores, transistors, etc.

solstice. 1. One of the two points of the **ecliptic** farthest from the **celestial equator;** one of the two points on the **celestial sphere** occupied by the sun at maximum **declination.**

That in the northern hemisphere is called the *summer solstice* and that in the southern hemisphere the *winter solstice.* Also called *solstitial point.*

2. That instant at which the sun reaches one of the solstices, about June 21 (summer solstice) or December 22 (winter solstice).

solstitial colure. That **great circle** of the **celestial sphere** through the **celestial poles** and the **solstices.**

solstitial point = **solstice.**

sonar. (From *so*und, *na*vigation, and *r*anging.) A method or system, analogous to **radar** used under water, in which high-frequency **sound waves** are emitted so as to be reflected back from objects, and used to detect the objects of interest. Called *asdic* by the British.

sonar capsule. A device designed to reflect high-frequency **sound waves.** See **sonar.**

The sonar capsule, if attached to a reentry body, may be used to locate the reentry body in case of a water landing.

sone. A unit of **loudness.** A simple tone of frequency 1000 cycles per second, 40 decibels above a listener's **threshold,** produces a loudness of 1 sone.

The loudness of any sound that is judged by the listener to be n times that of the 1-sone tone is n sones.

A millisone is equal to 0.001 sone.

The loudness scale is a relation between loudness and level above threshold for a particular listener. In presenting data relating loudness in sones to sound pressure level, or in averaging the loudness scales of several listeners, the thresholds (measured or assumed) should be specified.

sonic. 1. In aerodynamics, of or pertaining to the speed of sound; that which moves at **acoustic velocity** as in *sonic flow*; designed to operate or perform at the speed of sound, as in *sonic leading edge.* **2.** Of or pertaining to sound, as in *sonic amplifier.*

In sense 2, *acoustic* is preferred to *sonic.*

sonic agglomeration. The union of small particles suspended in a fluid medium into larger aggregates by the action of **sound waves.**

sonic barrier. A popular term for the large increase in **drag** that acts upon an aircraft approaching **acoustic velocity**; the point at which the speed of sound is attained and existing subsonic and supersonic flow theories are rather indefinite. Also called *sound barrier.*

sonic boom. A noise caused by a **shock wave** that emanates from an aircraft or other object traveling at or above **sonic velocity.**

A shock wave is a pressure disturbance and is received by the ear as a noise or clap.

sonic delay line = **acoustic delay line.**

sonic drilling. The process of cutting or shaping materials with an abrasive **slurry** driven by a reciprocating tool attached to an **electromechanical transducer** operating at **ultrasonic** frequencies.

sonic frequency = **audiofrequency.**

sonics. The technology of **sound** in processing and analysis. *Sonics* includes the use of sound in any noncommunication process.

sonic soldering. The method of joining metals by metallic bonding alloys through the use of mechanical vibrations to break up the surface oxides.

sonic speed. Acoustic velocity; by extension, the speed of a body traveling at a **Mach number** of 1.

sonic wave = sound wave.

sophisticated. Complex and intricate; making use of advanced art; requiring special skills to operate.

sorb. To take up gas by **sorption.**

sorbate. Gas taken up by a **sorbent.**

sorbent. The material which takes up gas by **sorption.**

sorption. The taking up of gas by **absorption, adsorption, chemisorption,** or any combination of these processes. See **absorption.**

sound. 1. An **oscillation** in pressure, stress, particle displacement, particle velocity, etc., in a medium with internal forces (e.g., elastic, viscous), or the superposition of such propagated oscillations. **2.** A sensation evoked by the oscillation described above in the human ear.

In case of possible confusion, the term *sound wave* or *elastic wave* may be used for concept 1 and the term *sound sensation* for concept 2. Not all sound waves can evoke an auditory sensation, e.g., ultrasound.

The medium in which the sound exists is often indicated by an appropriate adjective; e.g., *airborne, water borne, structure borne.*

sound absorption. Sound **absorption** is the change of **sound energy** into some other form, usually heat, in passing through a medium oron striking a surface.

sound barrier = sonic barrier.

sound energy. The energy which **sound waves** contribute to a particular medium.

sound energy density. At a point in a **sound field,** the **sound energy** contained in a given infinitesimal part of the medium divided by the volume of that part of the medium.

The terms *instantaneous energy density, maximum energy density,* and *peak energy density* have meanings analogous to the related terms used for sound pressure.

In speaking of average energy density in general, it is necessary to distinguish between the space average (at a given instant) and the time average (at a given point).

sound energy flux. The average rate of flow of **sound energy** for one period through any specified area.

In a medium of density ρ for a plane or spherical free wave having a velocity of propagation c, the sound energy flux through the area S corresponding to an effective sound pressure p is

$$J = (p^2S/\rho c) \cos \theta$$

where θ = the angle between the direction of propagation of the sound and the normal to the area S.

sound energy flux density = sound intensity.

sound field. A region containing **sound waves.** See **near field, far field.**

sounding. 1. In **geophysics,** any penetration of the natural environment for scientific observation. **2.** In meteorology, same as **upper air observation.** However, a common connotation is that of a single complete **radiosonde** observation. **3. = air sounding.**

sounding rocket. A **rocket** that carries aloft equipment for making observations of or from the **upper atmosphere.** See **air sounding.** Compare **probe,** sense 3.

Usually a sounding rocket has a near vertical trajectory.

sound intensity. In a specified direction at a point, the average rate of **sound energy** transmitted in the specified direction through a unit area normal to this direction at the point considered. Also called *sound energy flux density, sound power density.*

sound level. Specifically, a weighted **sound pressure level,** obtained by the use of metering characteristics and the weightings A, B, or C specified in American Standard Publication Z24.3–1944: *Sound Level Meters for Measurement of Noise and Other Sounds.* The weighting employed must always be stated. The reference pressure is 0.0002 microbar.

A suitable method of stating the weighting is, for example, *The A-sound level was 43 decibels.*

sound power. Of a source, the total **sound energy** radiated by the source per unit of time.

sound power density = sound intensity.

sound pressure. At a point, the total instantaneous pressure at that point in the presence of a **sound wave** minus the **static pressure** at that point. See **effective sound pressure.**

sound pressure level. In decibels, 20 times the logarithm to the base 10 of the ratio of the **sound pressure** to the reference pressure. The reference pressure must be explicitly stated.

The following reference pressures are in common use: (a) 2×10^{-4} microbar, (b) 1 microbar. Reference pressure (a) is in general use for measurements concerned with hearing and with sound in air and liquids, whereas (b) has gained widespread acceptance for calibration of transducers and various kinds of sound measurements in liquids.

Unless otherwise explicitly stated, it is to be understood that the sound pressure is the effective (root-mean-square) sound pressure.

It is to be noted that in many sound fields the sound pressure ratios are not the square roots of the corresponding power ratios.

sound probe. A device that responds to some characteristic of an **acoustic wave** (e.g., sound pressure, particle velocity) and that can be used to explore and determine this characteristic in a **sound field** without appreciably altering that field.

sound wave. A mechanical disturbance advancing with infinite velocity through an elastic medium and consisting of longitudinal displacements of the medium, i.e., consisting of com-

pressional and rarefactional displacements parallel to the direction of advance of the disturbance; a longitudinal wave. Sound waves are small-amplitude **adiabatic** oscillations. The wave equation governing the motion of sound waves has the form

$$\nabla^2\varphi = (1/c^2)\ (\partial^2\varphi/\partial t^2)$$

where ∇^2 is the Laplace operator, φ is the velocity potential, c is the speed of sound, and t is the time; the density variations and velocities are small. As so defined, this includes waves outside the frequency limits of human hearing, which limits customarily define sound. Also called *acoustic wave, sonic wave.* See **ultrasonic, infrasonic, pressure wave.**

Gases, liquids, and solids transmit sound waves, and the propagation velocity is characteristic of the nature and physical state of each of these media. In those cases where a steadily vibrating sound generator acts as a source of waves, one may speak of a uniform wave train; but in other cases (explosions, lightning discharges) a violent initial disturbance sends out a principal wave, followed by waves of more or less rapidly diminishing amplitude.

source. **1.** The location or device from which energy emanates as a *sound source, heat source,* etc. **2.** Specifically, in the mathematical representation of fluid flow, a hypothetical point or place from which fluid emanates.

The strength of a source; the rate of mass flow of unit density across a curve enclosing the source is given by

$$Q = 2\pi\, r v_r$$

where r is the distance from the source and v_r is the radial speed.

3. Specifically, the device which supplies **signal power** to a transducer.

southbound node = descending node.

South Tropical Disturbance. An elongated dark band in the cloud surface of Jupiter at about the latitude of the **Great Red Spot.** It was first seen in 1901 as a dark spot which then spread rapidly. It has at times exceeded 180° of longitude in length and, like the Red Spot, appears and disappears intermittently.

SP *(abbr)* = **solid propellant.**

space. **1.** Specifically, the part of the universe lying outside the limits of the earth's atmosphere. **2.** More generally, the volume in which all celestial bodies, including the earth, move.

space-air vehicle. A vehicle operable either within or above the **sensible atmosphere.** Also called *aerospace vehicle.*

space biology = bioastronautics.

space capsule. A container used for carrying out an experiment or operation in space.

A capsule is usually assumed to carry an organism or equipment.

space charge. **1.** The electric charge carried by a cloud or stream of **electrons** or **ions** in a vacuum or a region of low gas pressure when the charge is sufficient to produce local changes in the potential distribution. **2.** The net electric charge within a given volume.

space coordinates. A three-dimensional system of **Cartesian coordinates** by which a point is located by three **magnitudes** indicating distance from three planes which intersect at a point.

spacecraft. Devices, manned and unmanned, which are designed to be placed into an **orbit** about the earth or into a **trajectory** to another **celestial body.**

From 1957 through 1962 spacecraft were designated by the year and a Greek letter assigned in the order of launching, as 1958α for the first satellite of 1958. When more than one object was put in orbit by a single launch vehicle, each object was numbered, as 1961o2. (Space probes were not included in this system until 1960.) Beginning January 1, 1963, arabic numerals supplanted Greek letters in the scientific designations of all spacecraft with a lifetime of more than 90 minutes. Thus, the first satellite launched in 1963 was *1963–1*, the last was *1963–55*. When more than one component is put in orbit, alphabetical suffixes are added to the designations, as *1963–4A*. The letter A usually designates the component carrying the principal scientific payload; B, C, etc., are used as needed for any subsidiary payloads and then for inert components in order of maximum brightness. The designation system was promulgated formally in the *COSPAR Guide to Rocket and Satellite Information and Data Exchange.* The *Guide* has been published in full in *COSPAR Information Bulletin No.* 9, July 1962, and in *IGY Bulletin No. 61*, July 1962.

Table XIV is a listing of scientific satellites and space probes launched through 1964 and is reprinted from the *IG Bulletin* (*International Geophysics Bulletin*) published by the National Academy of Sciences.

space equivalent. A condition within the earth's atmosphere that is virtually identical, in terms of a particular function, with a condition in outer space.

For example, at 50,000 feet, the drop in air pressure and the scarcity of oxygen creates a condition, so far as respiration is concerned, that is equivalent to a condition in outer space where no appreciable oxygen is present; thus, a physiological space equivalent is present in the atmosphere.

space medicine. A branch of **aerospace medicine** concerned specifically with the health of persons who make, or expect to make, flights into space beyond the **sensible atmosphere.**

space modulation. The combining of signals outside of an electronic device or conductor to form a signal of desired characteristics. See **modulation.**

space motion. Motion of a **celestial body** through **space.**

That component perpendicular to the line of sight is termed *proper motion* and that component in the direction of the line of sight, *radial motion.*

TABLE XIV.—SCIENTIFIC SATELLITES AND SPACE PROBES, OCTOBER 1957–MARCH 1965[a]

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements			
					Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1957α	Sputnik 1	USSR	10/4/57–early 1/58	Temperatures, pressures	227	947	96.17	65.1
1957β	Sputnik 2	USSR	11/3/57–4/14/58	Cosmic, UV, & X-radiation, dog	225	1671	103.75	65.3
1958α	Explorer 1	USA	2/1/58	Cosmic rays, micrometeoroids	360	2532	114.8	33.34
1958β	Vanguard 1	USA	3/17/58–	Geodesy, temperatures	658	3948	134.29	34.25
1958δ	Explorer 3	USA	3/26/58–6/28/58	Cosmic rays, micrometeoroids	195	2810	115.87	33.37
1958δ	Sputnik 3	USSR	5/15/58–4/6/60	Fields & particles, temperature, pressure, etc.	226	1881	105.95	65.2
1958ϵ	Explorer 4	USA	7/26/58–10/23/59	Corpuscular radiation	262	2221	110.27	50.29
1958[2]	Pioneer 1	USA	10/11/58–10/12/58	Fields & particles, micrometeoroids	Reached distance of 113,800 km			
1958[2]	Pioneer 2	USA	11/8/58–11/8/58	Fields & particles, micrometeoroids	Reached distance of 1550 km			
1958[2]	Pioneer 3	USA	12/6/58–12/7/58	Corpuscular radiation	Reached distance of 102,320 km			
1959[2]	Lunik 1	USSR	1/2/59–	Fields & particles, micrometeoroids	146.4[b]	197.2[b]	450 days	1[b]
1959α	Vanguard 2	USA	2/17/59–	Cloud-cover scan	558	3322	125.85	32.88
1959[2]	Pioneer 4	USA	3/3/59–	Corpuscular radiation	147.6[b]	173.6[b]	406.9 days	.127[b]
1959δ	Explorer 6	USA	8/7/59–before 7/61	Fields & particles, cloud cover, micrometeoroids	251	42,418	~750	46.9
1959[2]	Lunik 2	USSR	9/12/59–9/13/59	Cosmic rays, fields, micrometeoroids	Lunar Impact			
1959η	Vanguard 3	USA	9/18/59–	Geomagnetic field	515	3748	130.2	33.3
1959θ	Lunik 3	USSR	10/4/59–3/60	Lunar photography	40,000[c]	480,000[c]	~15 days	—
1950ι	Explorer 7	USA	10/13/59–	Cosmic, UV, & X-rays; heat balance, etc.	550	1094	101.33	50.3
1960α	Pioneer 5	USA	3/11/60–	Corpuscular radiation, fields, micrometeoroids	120.5[b]	148.5[b]	311.6 days	3.35[b]
1960β	Tiros 1	USA	4/1/60–	Cloud-cover photos	690	750	99.19	48.33
1960γ	Transit 1B	USA	4/13/60–	Navigation	375	771	96	51
1960ϵ	Sputnik 4	USSR	5/15/60–9/5/62	Test life-support systems, temperature	312	369	91.1	65
1960η1	Transit 2A	USA	6/22/60–	Navigation	626	1070	101.7	66.7
1960η2	Solar Radiation 1 (Greb)	USA	6/22/60–	Solar UV and X-radiation	615	1057	101.5	66.8
1960ι	Echo 1	USA	8/12/60–	Passive communications relay	1521	1688	118.3	47.2
1960λ	Sputnik 5	USSR	8/19/60–8/20/60	Test life-support systems (re-entry)	306	339	90.7	64.95
1960ν	Courier 1B	USA	10/4/60–	Active communications relay	806	1059	107	28.3
1960ξ	Explorer 8	USA	11/3/60–	Ionosphere direct measurement	415	2290	112.7	49.9
1960π	Tiros 2	USA	11/23/60–	Cloud cover and infrared	623	729	98.37	48.5
1960ρ	Sputnik 6	USSR	12/1/60–12/2/60	Medical, biological, physics studies	187.3	265	88.47	65
1961β	Sputnik 7	USSR	2/4/61–2/26/61	Test life-support systems	223.5	327.6	89.8	64.95
1961γ3	Sputnik 8	USSR	2/12/61–2/25/61	Launch probe to Venus	6601	6658	89.7	—
1961γ1	Venus Probe	USSR	2/12/61–	Fields and particles, micrometeoroids	107[b]	152[b]	300 days	0.3[b]

See footnotes at end of table, page 266.

TABLE XIV.—(CONTINUED)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements			
					Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1961δ	Explorer 9	USA	2/16/61–4/9/64	Atmospheric density	636	2583	118.3	38.63
1961η	Transit 3B/Lofti	USA	2/22/61–3/30/61	Navigation, VLF propagation	188	822	94.5	28.36
1961θ	Sputnik 9	USSR	3/9/61–3/9/61	Test life-support systems (reentry)	183.5	248.8	—	64.93
1961ι	Sputnik 10	USSR	3/25/61–3/25/61	Test life-support systems (reentry)	178.1	247	88.4	64.9
1961κ	Explorer 10	USA	3/25/61–	Fields and particles	177	233,000	~6720	33
1961μ	Vostok 1	USSR	4/12/61–4/12/61	Manned orbital flight	181	327	89.1	64.95
1961ν	Explorer 11	USA	4/27/61–	Gamma radiation	489	1792	108.1	28.8
1961ο1	Transit 4A	USA	6/29/61–	Navigation	859	1003	103.7	67
1961ο2	Injun/SR 3	USA	6/29/61–	Cosmic rays, solar X-ray radiation	859	1020	103.8	67
1961ρ	Tiros 3	USA	7/12/61–	Cloud cover and infrared	742	815	100.4	47.8
1961τ	Vostok 2	USSR	8/6/61–8/7/61	Manned orbital flight	178	257	88.6	64.93
1961υ	Explorer 12	USA	8/16/61–	Energetic particles, magnetic fields	294	77,340	~1585	33
1961φ	Ranger 1	USA	8/23/61–8/30/61	Spacecraft test, fields and particles	170	503	91.1	32.9
1961χ	Explorer 13	USA	8/25/61–8/28/61	Micrometeoroids	119	1162	97.5	37.7
1961αα	MA-4	USA	9/13/61–9/13/61	Mercury orbital test (unmanned)	161	255.3	88.6	32.57
1961αδ2	West Ford	USA	10/21/61–12/5/61	Long-range communications test	3508	3734	165.76	95.9
1961αη1	Transit 4B	USA	11/15/61–	Navigation	937	1127	105.6	32.42
1961αη2	Traac	USA	11/15/61–	Attitude control, radiation	905	1159	105.6	32.43
1961αθ	Ranger 2	USA	11/18/61–11/20/61	Spacecraft test, fields and particles	152.7	234.5	88.3	33.3
1961αι	MA-5	USA	11/29/61–11/29/61	Mercury orbital test (chimpanzee)	161	255.3	88.6	32.57
1961ακ2	Oscar 1	USA	12/12/61–1/31/62	Radio propagation	235	415	91.1	81.2
1962α	Ranger 3	USA	1/26/62–	Impact on moon, TV photoggraphy & X-ray spectroscopy of lunar surface, rough-land seismometer on moon	147.3[b]	173.5[b]	406.439 days	.3988[b]
1962β	Tiros 4	USA	2/8/62–	Cloud cover, ice reconnaissance, infrared	708	845	100.4	48.3
1962γ	Friendship 7	USA	2/20/62–2/20/62	Manned orbital flight	161.04	261.15	88.5	32.54
1962ζ	OSO 1	USA	3/7/62–	UV, X-ray, & gamma radiation	552.8	595.2	96.15	32.8
1962θ	Cosmos 1	USSR	3/16/62–5/25/62	Earth's radiation belts, cosmic rays, solar radiation, cloud distribution	217	980	95.4	49
1962ι	Cosmos 2	USSR	4/6/62–8/20/63	Cosmic rays, geomagnetic field, cloud distribution, solar radiation, cosmic dust	211	1545	102.25	49
1962μ	Ranger 4	USA	4/23/62–4/26/62	See Ranger 3	Lunar impact at 7:49:53 a.m. EST 4/26/62 at 12.9° south lunar latitude and 129.1° west lunar longitude			

See footnotes at end of table, page 266.

TABLE XIV.—(CONTINUED)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements			
					Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1962ν	Cosmos 3	USSR	4/24/62–10/17/62	*Cosmos* series	229	719	92.5	49.98
1962ξ	Cosmos 4	USSR	4/26/62–4/29/62	*Cosmos* series (re-entry)	298	330	90.6	65
1962o	Ariel	USA/UK	4/26/62–	Ionosphere, electron density & temperature, ion composition, solar UV, cosmic rays	389.7	1213.7	100.9	53.87
1962τ	Aurora 7	USA	5/24/62–5/24/62	Manned orbital flight	160.9	268.5	88.3	32.5
1962υ	Cosmos 5	USSR	5/28/62–5/2/63	*Cosmos* series	203	1600	101.5	49.07
1962χ2	Oscar 2	USA	6/2/62–6/21/62	Radio propagation	208	386	90.5	74.26
1962$\alpha\alpha$	Tiros 5	USA	6/19/62–	Cloud cover	591	972	100.5	38.1
1962$\alpha\delta$	Cosmos 6	USSR	6/30/62–8/8/62	*Cosmos* series	274	360.5	90.1	49
1962$\alpha\epsilon$	Telstar	USA	7/10/62–	Communications repeater	955	4830.9	157.8	44.79
1962$\alpha\iota$	Cosmos 7	USSR	7/28/62–8/1/62	*Cosmos* series (re-entry)	201.5	351.1	90.1	65
1962$\alpha\mu$	Vostok 3	USSR	8/11/62–8/15/62	Manned orbital flight	172.8	220.8	88.13	64.83
1962$\alpha\nu$	Vostok 4	USSR	8/12/62–8/15/62	Manned orbital flight	179	254	88.5	65
1962$\alpha\xi$	Cosmos 8	USSR	8/18/62–8/17/63	*Cosmos* series	255.4	602.5[b]	92.9	49
1962$\alpha\rho$	Mariner 2	USA	8/27/62–	Venus probe[d]	105.4[b]	167.1[b]	345.9 days	1.66[b]
1962$\alpha\psi$	Tiros 6	USA	9/18/62–	Cloud cover	684	711	98.7	58.3
1962$\alpha\omega$	Cosmos 9	USSR	9/27/62–10/1/62	*Cosmos series*	303	356	90	65
1962$\beta\alpha$	Alouette	USA/Canada	9/29/62–	Topside ionosphere sounder	998	1046	105	80
1962$\beta\gamma$	Explorer 14	USA	10/2/62–	Energetic particles, magnetic fields	280.3	98,475	36.4 hours	32.9
1962$\beta\delta$	Sigma 7	USA	10/3/62–10/3/62	Manned orbital flight	161	283	88.5	32.56
1962$\beta\zeta$	Cosmos 10	USSR	10/17/62–10/21/62	*Cosmos* series	203	335	90.2	65
1962$\beta\eta$	Ranger 5	USA	10/18/62–	See Ranger 3	142.1[b]	159.8[b]	370.22 days	.44422[b]
1962$\beta\theta$	Cosmos 11	USSR	10/20/62–5/18/64	*Cosmos* series	245	920	96.1	45
1962$\beta\lambda$	Explorer 15	USA	10/27/62–	Artificial radiation belts	311.7	17,316.5	5.2 hours	18.02
1962$\beta\mu$	Anna 1B	USA	10/31/62–	Geodetic measurements	1077	1185	107.920	50.14
1962$\beta\nu$3	Mars 1	USSR	11/1/62–	Mars probe. Radio transmission ceased after 106 million kilometers.	Heliocentric orbit			
1962$\beta\tau$2	Injun 3	USA	12/13/62–	Cosmic rays	235	270	116	70
1962$\beta\upsilon$	Relay 1	USA	12/13/62–	Communications repeater	1320	7420	185.09	47.47
1962$\beta\chi$	Explorer 16	USA	12/16/62	Micrometeoroids	750	1180	104.4	52.01
1962$\beta\psi$	Transit 5A	USA	12/19/62–	Navigation	705	726	99.2	90.62
1962$\beta\omega$	Cosmos 12	USSR	12/22/62–12/30/62	*Cosmos* series	211	405	90.45	65

See footnotes at end of table, page 266.

TABLE XIV.—(CONTINUED)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements: Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1963-4A	Syncom I	USA	2/14/63	Experimental synchronous communications satellite	34,228	36,974	1426.5	33.51
1963-6A	Cosmos XIII	USSR	3/21/63–3/29/63	Research program in space	204	336	89.77	64.97
1963-8B	Lunik IV	USSR	4/2/63	Probe towards moon	Closest approach to moon 8530 km at 9:24 EST 4/5/63.			
1963-9A	Explorer XVII	USA	4/3/63	Measurements of density, pressure, temperature, and composition of the earth's atmosphere	254	963	96.4	57.63
1963-10A	Cosmos XIV	USSR	4/23/63–8/29/63	*Cosmos* series	265	512	92.1	48.95
1963-11A	Cosmos XV	USSR	4/22/63–4/27/63	*Cosmos* series	173	371	89.77	65.00
1963-12A	Cosmos XVI	USSR	4/28/63–5/8/63	*Cosmos* series	207	401	90.4	65.02
1963-13A	Telstar II	USA	5/7/63	Experimental active repeater communications satellite	971	10,508	221.5	42.7
1963-15A	Faith 7	USA	5/15/63–5/16/63	Manned orbital flight	161	267	88.74	32.5
1963-17A	Cosmos XVII	USSR	5/22/63	*Cosmos* series	260	788	94.82	49.03
1963-18A	Cosmos XVIII	USSR	5/24/63–6/2/63	*Cosmos* series	209	301	89.44	65.02
1963-20A	Vostok V	USSR	6/14/63–6/19/63	Manned orbital flight	181	235	88.4	65
1963-21B	Lofti IIA	USA	6/15/63–7/18/63	Measurement of intensity of VLF signals through the ionosphere	183	723	93.7	69.91
1963-21C	Solar Radiation IV	USA	6/15/63–8/1/63	Measurements of solar ultraviolet and x-radiation	177	772	94.1	69.79
1963-23A	Vostok VI	USSR	6/16/63–6/19/63	Manned orbital flight	183	233	88.3	65
1963-24A	Tiros VII	USA	6/19/63	Photography of earth's cloud cover; measurement of infrared in various spectral bands	620	646	97.4	58.2
1963-26A	Res. Satellite for Geophysics	USA	6/28/63	Geophysical research satellite	415	1303	102.1	49.74
1963-31A	Syncom II	USA	7/26/63	Experimental synchronous communications satellite	35,776	35,780	1435.9	33.1
1963-33A	Cosmos XIX	USSR	8/6/63–3/30/64	*Cosmos* series	270	519	92.2	49
1963-40B	Cosmos XX	USSR	10/18/63–10/30/63	*Cosmos* series	206	311	89.55	65
1963-43A	Polyot I	USSR	11/1/63	Space maneuvers	343	1437	102.4	58.92
1963-44A	Cosmos XXI	USSR	11/11/63–11/14/63	*Cosmos* series	195	229	88.5	64.83
1963-45A	Cosmos XXII	USSR	11/16/63–11/22/63	*Cosmos* series	205	394	90.3	64.93
1963-46A	Explorer XVIII	USA	11/27/63	Measurements of magnetic fields, cosmic rays and solar winds	192	197,616	5666.	33.34
1963-47A	Centaur 2	USA	11/27/63	Engineering test vehicle	570	1682	107.6	30.33
1963-50A	Cosmos XXIII	USSR	12/13/63–3/27/64	*Cosmos* series	240	613	92.9	49

See footnotes at end of table, page 266.

TABLE XIV.—(CONTINUED)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements: Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1963-52A	Cosmos XXIV	USSR	12/19/63–12/28/63	*Cosmos* series	211	408	90.5	65
1963-53A	Explorer XIX	USA	12/19/63	Study of atmospheric density	592	2385	115.8	78.60
1963-54A	Tiros VIII	USA	12/21/63	Photography of earth's cloud cover	702	753	99	58.5
1964-1D	Solar Radiation	USA	1/11/64	Measurement of solar ultraviolet and x-radiation	909	931	103.4	69.9
1964-3A	Relay 2	USA	1/21/64	Active repeater communications satellite, measures radiation damage to solar cells, measures radiation in orbit.	2,089	7,413	194.7	46.3
1964-4A	Echo 2	USA	1/25/64	Passive communications satellite	1,033	1,313	109	81.5
1964-5A	Saturn SA-5	USA	1/29/64	Engineering test vehicle	261	752	94.8	31.44
1964-6A	Elektron 1	USSR	1/30/64	Study inner radiation region	406	7,100	169	61
1964-6B	Elektron 2	USSR	1/30/64	Study outer radiation region	460	68,200	1360	61
1964-7A	Ranger 6	USA	1/30/64–2/2/64	Lunar impact. Photography of lunar surface.	Impacted on moon at 0924 UT 2 Feb. 1964 at 9.4° N lunar latitude and 21.5° E lunar longitude.			
1964-10A	Cosmos 25	USSR	2/27/64–11/21/64	*Cosmos* series	272	526	92.27	49
1964-13A	Cosmos 26	USSR	3/18/64–9/28/64	*Cosmos* series	271	403	91	49
1964-14A	Cosmos 27	USSR	3/27/64–3/28/64	*Cosmos* series	192	237	88.7	46.8
1964-15A	Ariel 2(UK-2)	USA/UK	3/27/64	Measure galactic radio noise, vertical distribution of ozone, micrometeoroid flux	290	1357	101.38	51.66
1964-16D	Zond 1	USSR	4/2/64	Space probe for developing a system for interplanetary flights	Heliocentric orbit on trans-Venus trajectory			
1964-17A	Cosmos 28	USSR	4/4/64–4/12/64	*Cosmos* series	209	395	90.38	65
1964-18A	Gemini GT-1	USA	4/8/64–4/12/64	Test of unmanned Gemini spacecraft	160	320	89	32.6
1964-19B	Polyot 2	USSR	4/12/64	Space maneuvers	310	500	92.4	58.06
1964-21A	Cosmos 29	USSR	4/25/64–5/2/64	*Cosmos series*	204	309	89.52	65.1
1964-23A	Cosmos 30	USSR	5/18/64–5/26/64	*Cosmos* series	207	383	90.24	65.9
1964-25A	Saturn SA-6	USA	5/28/64–6/1/64	Engineering test vehicle	99	122	88.56	31.8
1964-28A	Cosmos 31	USSR	6/6/64–10/20/64	*Cosmos* series	228	508	91.6	49
1964-29A	Cosmos 32	USSR	6/10/64–6/18/64	*Cosmos* series	209	333	89.78	51.35
1964-33A	Cosmos 33	USSR	6/23/64–7/1/64	*Cosmos* series	209	293	89.38	65
1964-34A	Cosmos 34	USSR	7/1/64–7/9/64	*Cosmos* series	205	360	90	65
1964-38A	Elektron 3	USSR	7/10/64	Study inner radiation region	405	7,040	168	60.9
1964-38B	Elektron 4	USSR	7/10/64	Study outer radiation region	459	66,235	1314	60.9
1964-39A	Cosmos 35	USSR	7/15/64–7/23/64	*Cosmos* series	217	268	89.2	51.3

See footnotes at end of table, page 266.

Table XIV.—(continued)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements: Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1964-41A	Ranger 7	USA	7/28/64–7/31/64	Television photography of the lunar surface (4,316 photographs of excellent quality were obtained.)	Impacted on moon at 1326 UT, 31 July 1964 at 10.7° S lunar latitude, 20.7° N lunar longitude			
1964-42A	Cosmos 36	USSR	7/30/64–2/28/65	*Cosmos* series	259	503	91.9	49
1964-44A	Cosmos 37	USSR	8/14/64–9/22/64	*Cosmos* series	205	300	89.45	65
1964-46A	Cosmos 38	USSR	8/18/64–11/8/64	*Cosmos* series	210	876	95.2	56.2
1964-46B	Cosmos 39	USSR	8/18/64–11/17/64	*Cosmos* series	210	876	95.2	56.2
1964-46C	Cosmos 40	USSR	8/18/64–11/18/64	*Cosmos* series	210	876	95.2	56.2
1964-47A	Syncom 3	USA	8/19/64	Synchronous communications satellite	1,130	37,941	692	16.7
1964-49D	Cosmos 41	USSR	8/22/64	*Cosmos* series	394	39,855	715	64
1964-50A	Cosmos 42	USSR	8/22/64	*Cosmos* series	232	1,099	97.8	49
1964-50C	Cosmos 43	USSR	8/22/64	*Cosmos* series	232	1,099	97.8	49
1964-51A	Explorer 20	USA	8/25/64	Explore ionospheric irregularities, measure cosmic noise, measure local ion concentration and temperature	866	1,009	103.8	89.9
1964-52A	Nimbus 1	USA	8/28/64	Photography of earth's cloud cover; measurements of infrared radiation	422	931	98.3	98.7
1964-53A	Cosmos 44	USSR	8/23/64	*Cosmos* series	618	860	99.5	65
1964-54A	OGO-1	USA	9/5/64	Twenty experiments to measure fields, particles, and radiation in space	283	149,420	3839	31.1
1964-55A	Cosmos 45	USSR	9/13/64–9/18/64	*Cosmos* series	206	327	89.69	64.9
1964-57A	Saturn SA-7	USA	9/18/64–9/22/64	Engineering test vehicle	183	228	88.35	31.7
1964-59A	Cosmos 46	USSR	9/24/64–10/2/64	*Cosmos* series	215	271	89.2	51.3
1964-60A	Explorer 21 (IMP-2)	USA	10/4/64	Measurements of magnetic fields, cosmic rays and solar winds	191	95,596	2097	33..5
1964-62A	Cosmos 47	USSR	10/6/64–10/7/64	*Cosmos* series	177	413	90	64.6
1964-64A	Explorer 22 (BE-2)	USA	10/10/64	Study ionosphere, measure electron density and temperature, geodetic measurements	881	1,088	104.8	79.7
1964-65A	Voskhod 1	USSR	10/12/64–10/13/64	Manned orbital flight	178	409	90.1	64
1964-66A	Cosmos 48	USSR	10/14/64–10/20/64	*Cosmos* series	203	296	89.4	65.1
1964-69A	Cosmos 49	USSR	10/24/64	*Cosmos* series	260	490	91.83	49
1964-70A	Cosmos 50	USSR	10/28/64–11/5/64	*Cosmos* series	196	241	88.7	51.3

See footnotes at end of table, page 266.

TABLE XIV.—(CONTINUED)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements			
					Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1964-73A	Mariner III	USA	11/5/64	Measure radiation, magnetic fields, and micrometeorites in space and near Mars. Photograph Mars and determine characteristics of Martian atmospheric pressure	Heliocentric orbit on trans-Mars trajectory 460 524	 989 2,497	 99.3 116.20	 51.95 81.4
1964-74A	Explorer 23	USA	11/6/64	Study micrometeoroids				
1964-76A	Explorer 24 (AD)	USA	1/21/64	Study air density and temperature variations of the upper atmosphere	524	2,492	116.15	81.4
1964-76B	Explorer 25 (I-B)	USA	1/21/64	Measure particle flux and energy				
1964-77A	Mariner IV	USA	11/28/64	Measure radiation, magnetic fields, and micrometeorites in space and near Mars. Photograph Mars and determine characteristics of Martian atmospheric pressure	Heliocentric orbit on trans-Mars trajectory			
1964-78C	Zond 2	USSR	11/30/64	Research in interplanetary space	Heliocentric orbit on trans-Mars trajectory			
1964-82A	Centaur (AC-4)	USA	12/11/64–12/12/64	Engineering test vehicle	163	171	87.86	30.69
1964-80A	Cosmos 51	USSR	12/9/64	*Cosmos* series	264	554	92.5	48.8
1964-84A	San Marco 1	Italy/USA	12/15/64	Measure air density and investigate ionosphere characteristics	206	821	94.89	37.8
1964-86A	Explorer 26 (EPE-D)	USA	12/21/64	Study natural and artificial radiation regions	306	26,200	456	20
1965-1A	Cosmos 52	USSR	1/11/65–1/19/65	*Cosmos* series	205	304	89.5	65
1965-4A	Tiros 9	USA	1/22/65	Photography of earth's cloud cover	740	2580	119	96
1965-6A	Cosmos 53	USSR	1/30/65	*Cosmos* series	227	1192	98.7	48.8
1965-7A	OSO 2	USA	2/3/65	Study solar x-rays, gamma rays and ultraviolet radiation	552	632	97	33
1965-9A	Pegasus 1	USA	2/16/65	Study micrometeoroids	497	745	97	32
1965-10A	Ranger 8	USA	2/17/65–2/20/65	Television photography of lunar surface (7,137 photographs of excellent quality were obtained)	Impacted on moon at 0958 UT, 20 Feb 1965; at 2.7° N, 24.8° E lunar coordinates			
1965-11A	Cosmos 54	USSR	2/21/65	*Cosmos* series	280	1856	106.2	56.1
1965-11B	Cosmos 55	USSR	2/21/65	*Cosmos* series	280	1856	106.2	56.1
1965-11C	Cosmos 56	USSR	2/21/65	*Cosmos* series	280	1856	106.2	56.1
1965-12A	Cosmos 57	USSR	2/22/65–2/22/65	*Cosmos* series	175	512	91.1	64.6
1965-14A	Cosmos 58	USSR	2/26/65	*Cosmos* series	581	659	96.8	65
1965-15A	Cosmos 59	USSR	3/7/65	*Cosmos* series	209	339	89.7	65
1965-18A	Cosmos 60	USSR	3/12/65	*Cosmos* series	201	287	89.1	64.6
1965-20A	Cosmos 61	USSR	3/15/65	*Cosmos* series	173	1837	106	56
1965-20B	Cosmos 62	USSR	3/15/65	*Cosmos* series	173	1837	106	56
1965-20C	Cosmos 63	USSR	3/15/65	*Cosmos* series	173	1837	106	56
1965-22A	Voskhod 2	USSR	3/18/65–3/19/65	Manned orbital flight	173	495	90.9	65

See footnotes at end of table, page 266.

TABLE XIV.—(CONTINUED)

COSPAR designation	Popular name	Country	Lifetime (launch-decay)	Experiments	Initial orbital elements			
					Perigee (km)	Apogee (km)	Period (min)	Inclin. (deg)
1965-23A	Ranger 9	USA	3/21/65–3/24/65	Television photography of lunar surface	Impacted on moon at 1408 UT, 24 March 1965; at 12.9° S, 2.4° W lunar coordinates			
1965-24A	Gemini GT-3	USA	3/23/65–3/23/65	Manned orbital flight	161	230	88.27	32.6
1965-25A	Cosmos 64	USSR	3/25/65	*Cosmos* series	206	271	89.2	65

[a] Reprinted by permission of the *International Geophysics Bulletin* of the National Academy of Sciences.
[b] Orbital elements given as perhelion and aphelion (in millions of kilometers) and inclination to ecliptic.
[c] Varied widely due to lunar and solar perturbations.
[d] Mariner's closest approach to Venus (about 34,760 km) came at 0759 UT, Dec. 14, 1962.

space polar coordinates. A system of **coordinates** by which a point on the surface of a sphere is located in three dimensions by (a) its distance from a fixed point at the center, called the pole; (b) the colatitude or angle between the polar axis (a reference line through the pole) and the radius vector (a straight line connecting the pole and the point); and (c) the longitude or angle between a reference plane through the polar axis and a plane through the radius vector and polar axis. See **polar coordinates, spherical coordinates, cylindrical coordinates.**

space probe. See **probe,** note, and **spacecraft,** note and table XIV.

space reddening. The observed reddening, or absorption of shorter **wavelengths,** of the light from distant **celestial bodies** due to **scattering** by small particles in interstellar **space.** Compare **red shift.**

space simulator. 1. Any device used to simulate one or more parameters of the space **environment** used for testing space systems or components. **2.** Specifically, a closed chamber capable of approximately the vacuum and normal environments of space.

space suit. A **pressure suit** for wear in space or at very low ambient pressures within the atmosphere, designed to permit the wearer to leave the protection of a **pressurized** cabin.

span. 1. The dimension of a craft measured between lateral extremities; the measure of this dimension. **2.** Specifically, the dimension of an **airfoil** from tip to tip measured in a straight line.

Span is not usually applied to vertical airfoils.

spark discharge. That type of gaseous **electrical discharge** in which the charge transfer occurs intermittently along a relatively constricted path of high ion density, resulting in high **luminosity.** It is of short duration and to be contrasted with the nonluminous **point discharge,** with the diffuse **corona discharge,** and also with the continuous **arc discharge.**

The exact meaning to be attached to the term *spark discharge* varies somewhat in the literature. It is frequently applied to just the transient phase of the establishment of any arc discharge. A lightning discharge is a large-scale spark discharge, though its very length introduces certain details not found in laboratory short-spark processes.

spark spectrum. The **spectrum** of an **ion.** The degree of ionization, or order of the spectrum, is indicated by a Roman numeral following the symbol for the element. The first spark spectrum is indicated by *II*, the second by *III*, and so on. Thus Fe *IV* indicates the spectrum of an iron atom which has lost three electrons. See **arc spectrum.**

spatial. Pertaining to **space.**

spatio. A combining form meaning **space.**

special perturbations. A method of **orbit** determination by numerical integration which takes into account the perturbing forces which are causing the orbit to depart from the orbit as calculated by **Kepler laws.**

specific. A modifier generally implying *per unit mass.*

specific heat. The ratio of the **heat** absorbed (or released) by unit mass of a system to the corresponding **temperature** rise (or fall). If this ratio varies with temperature, it must be defined as a differential quotient dQ/dT, where

dQ is the infinitesimal increment of heat per unit mass and dT is the infinitesimal increment of temperature.

For gases the thermodynamic process must be specified; two specific heats are defined, one being the specific heat in a constant-pressure process

$$c_p = (dQ/dT)_p$$

and the other, the specific heat in a constant-volume process

$$c_v = (dQ/dT)_v$$

In a perfect gas these are, by definition, constants with respect to temperature, and the difference of the specific heat at constant pressure and the specific heat at constant volume is equal to the gas constant:

$$R = c_p - c_v$$

specific humidity. In a system of moist air, the (dimensionless) ratio of the mass of **water vapor** to the total mass of the system. The specific humidity may be approximated by the **mixing ratio** for many purposes:

$$q = w/(1 + w)$$

where q is the specific humidity and w is the mixing ratio. See **absolute humidity, relative humidity, dew point.**

specific impulse (*symbol* I_{sp}). A performance parameter of a **rocket propellant,** expressed in seconds, equal to the **thrust** F in pounds divided by the weight flow rate $\dot{w}$ in pounds per second:

$$I_{sp} = F/^{\cdot}$$

Specific impulse is also equivalent to the effective exhaust velocity divided by the gravitational acceleration.

specific power. The **energy** delivered per pound of fuel in a **reactor** or in a **radioisotope** power source.

specific propellant consumption. The reciprocal of the **specific impulse,** i.e., the required **propellant** flow to produce one pound of thrust in an equivalent rocket.

specific speed. Of a pump, a parameter used to predict pump performance.

specific thrust = **specific impulse.**

specific volume (*symbol* v). Volume per unit mass of a substance. The reciprocal of density.

spectra. Plural of *spectrum.*

spectral. 1. Of or pertaining to a spectrum. **2.** Referring to thermal radiation properties, for ratios such as **emittance, reflectance,** and **transmittance,** at a specified wavelength; for powers, such as **emissive power,** within a narrow wavelength band centered on a specified wavelength.

spectral absorptance. See **absorptance,** note.

spectral emissivity. See **emissivity,** note.

spectral function. The Fourier representation of a given function; that is, the **Fourier transform** if the given function is aperiodic or the set of coefficients of the **Fourier series** if the given function is periodic. Also called *spectrum.* See **continuous spectrum, discrete spectrum.**

spectral line. A bright, or dark, line found in the **spectrum** of some radiant source. See **absorption line, emission line.**

Bright lines indicate emission, dark lines indicate absorption.

spectrograph. See **spectroscope.**

spectroheliogram. See **spectroheliograph.**

spectroheliograph. An instrument for taking photographs (spectroheliograms) of the image of the sun in **monochromatic** light. The wavelength of light chosen for this purpose corresponds to one of the **Fraunhofer lines,** usually the light of hydrogen or ionized calcium.

A similar instrument used for visual, instead of photographic, observations is a spectrohelioscope.

spectrohelioscope. See **spectroheliograph,** note.

spectrophotometer. A **photometer** which measures the **intensity** of radiation as a function of the **frequency** (or wavelength) of the radiation. Also called *spectroradiometer.* See **Dobson spectrophotometer.**

In one design, radiation enters the spectrophotometer through a slit and is dispersed by means of a prism. A bolometer having a fixed aperture scans the dispersed radiation so that the intensity over a narrow wave band is obtained as a function of frequency.

spectropyrheliometer. An instrument which measures the spectral distribution of the intensity of **direct solar radiation.** See **pyrheliometer, spectrophotometer.**

spectroscope. An apparatus to effect **dispersion** of radiation and visual display of the **spectrum** obtained.

A spectroscope with a photographic recording device is called a *spectrograph.*

spectroscopic binaries. See **binary star,** note.

spectrum. 1. In physics, any series of energies arranged according to **wavelength** (or **frequency**). **2.** The series of images produced when a **beam** of radiant energy is subject to **dispersion. 3.** Short for **electromagnetic spectrum** or for any part of it used for a specific purpose as the *radio spectrum* (10 kilocycles to 300,000 megacycles). **4.** In mathematics, = **function. 5.** In acoustics, the distribution of effective **sound pressures** or intensities measured as a function of frequency in specified frequency bands.

specular reflection. **Reflection** in which the reflected radiation is not diffused; reflection as from a mirror. Also called *regular reflection, simple reflection.* Compare **diffuse reflection.**

The angle between the normal to the surface and the incident beam is equal to the angle between the normal to the surface and the reflected beam.

Any surface irregularities on a specular reflector must be small compared to the wavelength of the incident radiation.

specular reflector. Any surface exhibiting **specular reflection.** Also called *regular reflector, simple reflector.*

specular transmission density. See **photographic transmission density,** note.

speed. Rate of motion.

Rate of motion in a straight line is called *linear speed,* whereas change of direction per unit time is called *angular speed.*

Speed and *velocity* are often used interchangeably although some authorities maintain that *velocity* should be used only for the *vector* quantity.

speed of light (*symbol* **c**). The speed of propagation of **electromagnetic radiation** through a perfect vacuum; a universal dimensional constant equal to 299,792.5 ± 0.4 kilometers per second. Also called velocity of light.

speed of relative movement Also called *relative speed.* See **relative movement.**

speed of sound (*symbol* c_s). The speed of propagation of sound waves. In the atmosphere

$$c_s = [\gamma\ (R^*/M_0)T_M]^{1/2}$$

where γ is the ratio of specific heat of air at constant pressure to that a constant volume, R^* is the universal gas constant, M_0 is the mean molecular weight of air at sea level, and T_M is the molecular scale temperature.

At sea level in the standard atmosphere, the speed of sound is 340.294 meters per second (1116.45 feet per second).

The concept of the speed of sound in the atmosphere loses its applicability at about 90 kilometers where the mean free path of air molecules approaches the wavelengths of sound waves.

sphere of influence. The surface in space about a **planet** where the ratio of the force with which the sun perturbs the motion of a particle about the planet, to the force of attraction of the planet equals the ratio of the force with which the planet perturbs the motion of a particle about the sun, to the force of attraction of the sun on the particle.

The volume inside this surface defines the region where the attracting body exerts the primary influence on a particle.

sphere of position. See **line of position,** note.

spherical angle. The angle between two intersecting **great circles.**

spherical coordinates. **1.** A system of **coordinates** defining a point on a sphere or spheroid by its angular distances from a **primary great circle** and from a reference secondary great circle, as latitude and longitude. See **celestial coordinates.** **2.** = **space polar coordinates.**

spherical excess. The amount by which the sum of the three angles of a **spherical triangle** exceeds 180°.

spherical stratification. See **horizontal stratification.**

spherical system. A **trajectory measuring system,** whose locus of the measured range is a sphere with the ground equipment at the center.

A unique point in space is determined by the intersection of three or more spheres. The term *spherical system* has been applied to systems using three or more **slant ranges** to determine space position.

spherical triangle. A closed figure having arcs of three **great circles** as sides.

spherical wave. A wave whose **phase-front** surfaces are spheres. Such waves propagate from a point source.

spherics. Variant spelling of **sferics.**

spheroid. An **ellipsoid;** a figure resembling a sphere.

Also called *ellipsoid* or *ellipsoid of revolution* from the fact that it can be formed by revolving an ellipse about one of its axes. If the shorter axis is used as the axis of revolution, an oblate spheroid results, and if the longer axis is used, a prolate spheroid results. The earth is approximately an oblate spheroid.

spheroidal excess. The amount by which the sum of the three angles of a triangle on the surface of a **spheroid** exceeds 180°.

spicules. Bright spikes extending into the **chromosphere** of the sun from below.

They are several hundred miles in diameter and extend outward 5000 to 10,000 miles. Spicules have a lifetime of several minutes and may be related to **granules.**

spin = **angular momentum** (in atomic and nuclear physics).

spin axis. The axis of rotation of the **rotor** of a **gyro.**

spineward acceleration. See **physiological acceleration.**

spinner. Rotating part of a radar **antenna** used to impart any subsidiary motion in addition to the primary slewing of the **beam.**

spin rocket. A small **rocket** that imparts spin to a larger **rocket vehicle** or **spacecraft.**

spin stabilization. Directional stability of a spacecraft obtained by the action of gyroscopic forces which result from spinning the body about its axis of symmetry.

spin table. A flat round platform on which human and animal subjects can be placed in various positions and rapidly rotated, much as

on a phonograph record, in order to simulate and study the effects of prolonged tumbling at high rates.

Complex types of tumbling can be simulated by mounting the spin table on the arm of a centrifuge.

spiral layer = **Ekman layer.**

spiral scanning. **Scanning** in which the direction of maximum radiation describes a portion of a spiral. The **rotation** is always in one direction.

spoiler. A plate, series of plates, comb, tube, bar, or other device that projects into the **airstream** about a body to break up or spoil the smoothness of the **flow,** especially such a device that projects from the upper surface of an airfoil, giving an increased **drag** and a decreased **lift.** Compare **deflector,** sense (a).

Spoilers are normally movable and consist of two basic types: the flap spoiler, which is hinged along one edge and lies flush with the airfoil or body when not in use, and the retractable spoiler, which retracts edgewise into the body.

spontaneous emission. The decay of an atom or ion in an excited energy state E_j to a lower state E_i without the influence of any external perturbation. This process results in the emission of a photon of energy

$$h\nu = E_j - E_i$$

where h is the Planck constant and ν is the frequency.

spontaneous-ignition temperature. In testing fuels, the lowest temperature of a plate or other solid surface adequate to cause ignition in air of a fuel upon the surface.

sporadic D. See **ionosphere.**

sporadic E. See **ionosphere.**

sporadic meteor. A **meteor** which is not associated with one of the regularly recurring **meteor showers** or streams.

spores. The reproductive element of the lower forms of living organism, usually unicellular.

spray electrification = **Lenard effect.**

spray region = **fringe region.**

spread reflection. Reflection from a rough surface with large irregularities. Also called *mixed reflection.*

spurious disk. The round image of perceptible diameter of a star as seen through a telescope, due to **diffraction** of light in the telescope.

spurious emission = **spurious radiation.**

spurious radiation. **1.** Any undesired **emission** from a radio **transmitter.** **2.** Any **electromagnetic radiation** from a radio **receiver.** Also called **spurious emission.**

spurious response. **Output** from a **receiver** due to a signal or signals having frequencies other than that to which the receiver is tuned.

spurious transmitter output. Any part of the **radio frequency** output of a transmitter which is not a component of the theoretical **output** as determined by the type of modulation and specified bandwidth limitations.

spurious tube counts. In radiation-counter tubes, **counts** other than **background counts** and those caused directly by the radiation to be measured.

Spurious counts are caused by failure of the quenching process, electrical leakage, and the like. Spurious counts may seriously affect measurement of background counts.

sputtering. Dislocation of surface atoms of a material from bombardment by high-energy atomic **particles.**

square wave. **1.** An **oscillation,** the amplitude of which shows periodic discontinuities between two values, remaining constant between jumps. **2.** Specifically, in radar a **pulse** initiated by a rapid rise to peak power, maintained at a constant peak power over the finite pulse length, and terminated by rapid decrease from peak power.

squib. **1.** Any of various small explosive devices. **2.** An explosive device used in the **ignition** of a **rocket.** Usually called an *igniter.*

squitch. A *squib*-operated swi*tch.*

squitter. Random firing, intentional or otherwise, of a **transponder** transmitter in the absence of **interrogation.**

SQUID = superconducting quantum interference devices

SSB (*abbr*) = **single sideband.**

SS loran. Sky-wave synchronized **loran,** or loran in which the **sky wave** rather than the ground wave from the **master** controls the **slave.** SS loran is used with unusually long baselines.

stability. **1.** The property of a body, as an aircraft or rocket, to maintain its attitude or to resist displacement, and, if displaced, to develop forces and moments tending to restore the original condition. **2.** Of a fuel, the capability of a **fuel** to retain its characteristics in an adverse **environment,** e.g. extreme temperature.

stability augmentation system. An auxiliary system to the basic manual **vehicle control system** whereby response of the control surfaces to inputs by the pilot can be adjusted to give a preselected vehicle response by selection of certain fixed gains in a standard **feedback** loop on control-surface output.

stabilized data. **Radar** data output corrected

for tilt or roll of an unstabilized radar **antenna,** such as shipboard installations, etc.

stable platforms. A **gyroscopic** device so designed as to maintain a plane of reference in space regardless of the movement of the vehicle carrying the stable platform.

stadimeter. An instrument for determining the distance to an object of known dimension by measuring the angle subtended at the observer by the object. The instrument is graduated directly in distance.

stadimetric. Pertaining to a navigational **fix** which involves a measure of distance.

stage. **1.** A self-propelled separable element of a **rocket vehicle.** See **multistage rocket.** **2.** A step or process through which a **fluid** passes, especially in compression or expansion. **3.** A set of **stator** blades and a set of **rotor** blades in an axial-flow compressor or in a turbine; an **impeller wheel** in a radial-flow compressor. See **multistage compressor, single-stage compressor, single-stage turbine.**

stage-and-a-half. A **liquid-propellant rocket** of which only part of the propulsion unit falls away from the **rocket vehicle** during flight, as in the case of **booster rockets** falling away to leave the **sustainer engine** to consume remaining fuel.

staging. The process or operation during the flight of a **rocket vehicle** whereby a full **stage** or **half stage** is disengaged from the remaining body and made free to decelerate or be propelled along its own flightpath. See **separation.**

stagnation point. A point in a field of **flow** about a body where the **fluid** particles have zero velocity with respect to the body.

stagnation pressure. **1.** The pressure at a **stagnation point.** **2.** In compressible flow, the pressure exhibited by a moving gas or liquid brought to zero velocity by an isentropic process. **3.** = **total pressure.** **4.** = **impact pressure.**

Because of the lack of a standard meaning, *stagnation pressure* should be defined when it is used.

stagnation region. Specifically, the region at the front of a body moving through a fluid where the fluid has negligible relative velocity.

standard. **1.** An exact value, or a concept, that has been established by authority or agreement, to serve as a model or rule in the measurement of a quantity or in the establishment of a practice or procedure. **2.** A document that establishes engineering and technical limitations and applications for items, materials, processes, methods, design, or engineering practices.

standard artillery atmosphere. A set of values describing atmospheric conditions on which ballistic computations are based: namely, no wind, a surface temperature of 15° C, a surface pressure of 1000 millibars, a surface relative humidity of 78 percent, and a lapse rate which yields a prescribed density-altitude relation.

standard artillery zone. A vertical subdivision of the **standard artillery atmosphere.** It may be considered a layer of air of prescribed thickness and density.

standard atmosphere. **1.** A hypothetical vertical distribution of atmospheric temperature, pressure, and density which, by international agreement, is taken to be representative of the **atmosphere** (see table XV) for purposes of pressure altimeter calibrations, aircraft performance calculations, aircraft and rocket design, ballistic tables, etc. The air is assumed to be devoid of dust, moisture, and water vapor and to obey the perfect gas law and the hydrostatic equation (the air is static with respect to the earth).

Standard atmospheres, sense **1**, which have been used are:

(**a**) The NACA standard atmosphere, also called *U.S. standard atmosphere*, prepared in 1925, which was supplanted by

(**b**) The ICAO standard atmosphere, adopted in 1952, which was extended to greater altitudes by

(**c**) The ARDC model atmosphere, 1956, and

(**d**) The U.S. extension to the ICAO standard atmosphere, adopted in 1956, which has been revised by

(**e**) The ARDC model atmosphere, 1959, which incorporated some satellite data which has been supplanted by

(**f**) The U.S. Standard Atmosphere—1962. (See Table XV).

2. (*abbr* **atm**). A standard unit of **atmospheric pressure,** defined as that pressure exerted by a 760-millimeter column of mercury at standard gravity (980.665 centimeters per second per second) at temperature 0° C.

1 standard atmosphere = 760 millimeters of mercury
= 29.9213 inches of mercury
= 1013.250 millibars

standard conditions = **standard temperature and pressure.**

standard deviation (*symbol* σ). A measure of the **dispersion** of data points around their mean value. It is the positive square root of the **arithmetic mean** of the squares of the deviation from the arithmetic mean of the **population:**

$$\sigma = \sqrt{\Sigma d^2 m/n}$$

where m is arithmetic mean; d is deviation from the arithmetic mean; and n is number of points.

standard-deviation estimate. See **standard deviation,** note.

standard error of estimate (*symbol* S). A measure of the **dispersion** (scatter) of data points with respect to a **curve of regression.** S is the positive square root of the **arithmetic mean** of the squares of the deviations from a curve of regression:

$$S = \sqrt{\Sigma d^2 R/n}$$

where d is deviation from R; R is curve of regression; and n is number of points.

S is a measure of the variation to be expected in making predictions from the regression equation.

standard gravity. See **gravity.**

standardization. 1. The act or process of reducing something to, or comparing it with, a **standard. 2.** A measure of uniformity. **3.** A special case of **calibration** whereby a known input is applied to a device or system for the purpose of verifying the output or adjusting the output to a desired level or scale factor.

Applied to **transducers, standardization** indicates adjustment of the output to a standard value within specified limits of error.

standardize = normalize.

standard pressure. 1. In meteorology, usually a pressure of 1000 millibars, but other pressures may be used as standard for specific purposes. **2.** In physics, a pressure of 1 **standard atmosphere.**

standard propagation. The **propagation** of **radio** energy over a smooth spherical earth of uniform dielectric constant and conductivity under conditions of standard **refraction** in the atmosphere, i.e., an atmosphere in which the index of refraction decreases uniformly with height at a rate of 12 N-units per 1000 feet. See **superstandard propagation, substandard propagation, standard atmosphere.**

Standard propagation results in a ray curvature due to refraction which has a value approximately one-fourth that of the earth's curvature, giving a radio horizon which is about 15 percent greater than the distance to the geometrical horizon. This is equivalent to straight-line propagation over a fictitious earth whose radius is four-thirds the radius of the actual earth.

standard refraction. The **refraction** which would occur in an idealized atmosphere in which the **index of refraction** decreases uniformly with height at the rate of 39×10^{-6} per kilometer. See **standard propagation.**

Standard refraction may be included in ground-wave calculations by use of an effective earth radius of 8.5×10^6 meters, or four-thirds the geometrical radius of the earth.

TABLE XV.—DEFINING PROPERTIES OF THE U.S. STANDARD ATMOSPHERE—1962

Geopotential Altitude, H, km	Molecular-scale temperature, T_M, °K	Geopotential Gradient, L'_M, °K/km	Molecular weight, M	Kinetic temperature, T, °K
0.000	288.15		28.9644	288.15
		−6.5		
11.000	216.65		28.9644	216.65
		0.0		
20.000	216.65		28.9644	216.65
		+1.0		
32.000	228.65		28.9644	228.65
		+2.8		
47.000	270.65		28.9644	270.65
		0.0		
52.000	270.65		28.9644	270.65
		−2.0		
61.000	252.65		28.9644	252.65
		−4.0		
79.000	180.65		28.9644	180.65
		0.0		
88.743	180.65		28.9644	180.65

Geometric Altitude, Z, km	Molecular-scale temperature, T_M, °K	Geometric Gradient, L_M, °K/km	Molecular weight, M	Kinetic temperature, T, °K
90	180.65		28.9644	180.65
		+3		
100	210.65		28.88	210.02
		+5		
110	260.65		28.56	257.00
		+10		
120	360.65		28.07	349.49
		+20		
150	960.65		26.92	892.79
		+15		
160	1,110.65		26.66	1,022.2
		+10		
170	1,210.65		26.40	1,103.4
		+7		
190	1,350.65		25.85	1,205.4
		+5		
230	1,550.65		24.70	1,322.3
		+4		
300	1,830.65		22.66	1,432.1
		+3.3		
400	2,160.65		19.94	1,487.4
		+2.6		
500	2,420.65		17.94	1,499.2
		+1.7		
600	2,590.65		16.84	1,506.1
		+1.1		
700	2,700.65		16.17	1,507.6

standard temperature. 1. A **temperature** that depends upon some characteristic of some substance, such as the melting, boiling, or freezing point, that is used as a reference standard of temperature. **2.** In physics, usually the ice point (0° C); less frequently, the temperature of maximum water density (4° C). **3.** In

meteorology, this has no generally accepted meaning, except that it may refer to the temperature at zero altitude in the standard atmosphere (15° C).

standard temperature and pressure (*abbr* **STP**). Usually a temperature of 0° C but also used to designate a temperature of 15° C and 1 **standard atmosphere** (see **standard pressure**).

standard time. See **time.**

standard value of gravity. See **acceleration of gravity.**

standing wave. A periodic **wave** having a fixed distribution in space which is the result of **interference** of progressive waves of the same frequency and kind. Such waves are characterized by the existence of **nodes** or partial nodes and **antinodes** that are fixed in space.

stand talker. A person on a static **test stand** responsible for coordinating and timing the preparations for a **static test.**

Stanton number (*symbol* N_{St}). A number expressing the ratio of the heat transmissions perpendicular and parallel to the flow direction, defined as $h/c_p\,\rho v$ where h is the heat transfer coefficient, c_p is the specific heat, ρ is the density, and v is the flow velocity.

star. 1. A self-luminous celestial body exclusive of nebulas, comets, and meteors; any one of the suns seen in the heavens. Distinguished from **planets** or planet **satellites** that shine by reflected light. See **navigational stars,** table VII. **2.** Any luminous body seen in the heavens.

The star (sense 1) of our solar system is the sun. In sense 2, *star* sometimes excludes the sun, the moon, and manmade satellites from the category.

star catalogue. A listing of stars giving positions for a specified mean equinox and equator.

Stars are often identified by catalogue numbers.

star classification. Stars are classified by their spectra, designated by letters, sometimes with numerical subdivisions, as *the sun is a* G1-*type star.* The seven main types with their principal spectral characteristics are, in order of decreasing temperature:

O He *II* absorption
B He *I* absorption
A H absorption
F Ca *II* absorption
G strong metallic lines
K bands developing
M very red

Also, the letters, P, W, Q, R, N, and S are used to designate comparatively rare types of stars which do not fall into the main series.

star cluster. A group of **stars** physically close together in space.

star grain = **star perforated grain.**

Stark effect. The broadening or splitting of a **spectral line** observed when a luminous gas is acted upon by a strong electric field.

star perforated grain. A hollow rocket-propellant **grain** with the cross section of the hole having a multipointed shape.

starting pressure. In rocketry, the minimum **chamber pressure** required to establish shock-free flow in the exit plane of a supersonic **nozzle.**

star tracker. A telescopic instrument on a **rocket** or other flight borne vehicle that locks onto a **celestial body** and gives **guidance** reference to the vehicle during flight. See **celestial guidance, sun tracker.**

state of the art. The level to which technology and science have at any designated cutoff time been developed in a given industry or group of industries.

state parameter = **thermodynamic function of state.**

state variable. Any independent variable in a problem which must be specified to define a condition of state, as for example a component of position.

static. 1. Involving no variation with time. **2.** Involving no movement, as in *static test.* **3.** Any radio **interference** detectable as **noise** in the audio stage of a receiver.

static conversion. Energy conversion in which no moving parts or equipment are utilized.

static firing. The firing of a **rocket engine** in a hold-down position to measure **thrust** and accomplish other tests.

static pressure (*symbol* p). **1.** The **pressure** with respect to a stationary surface tangent to the **mass-flow velocity vector. 2.** The pressure with respect to a surface at rest in relation to the surrounding fluid.

static test. An instance of **static testing.**

static testing. The testing of a **rocket** or other device in a stationary or hold-down position, either to verify structural design criteria, structural integrity, and the effects of limit loads or to measure the **thrust** of a rocket engine.

station. A location where measurements are made, e.g., along an **airfoil** in a **wind tunnel** test.

stationary orbit. An **orbit** in which the **satellite** revolves about the **primary** at the angular rate at which the primary rotates on its

axis. From the primary, the satellite thus appears to be stationary over a point on the primary.

A stationary orbit with respect to the earth is commonly called a *24-hour orbit*.

stationary wave. A **standing wave** in which the net energy **flux** is zero at all points.

Stationary waves can only be approximated in practice.

station constants. In **tracking** and **telemetry**, constants usually associated with instrumentation sites, e.g., survey coordinates, zeroing correction, etc.

station error. In geodesy and surveying, the difference, usually negligible, between the **astronomical** and **geodetic latitudes**, due to local gravitational anomalies.

station keeping. The sequence of maneuvers that maintains a **vehicle** in a predetermined **orbit.**

station pressure. The **atmospheric pressure** computed for the level of the station elevation.

This may or may not be the same as either the climatological station pressure or the actual pressure, the difference being attributable to the difference in reference elevations.

Station pressure usually is the base value from which sea-level pressure and altimeter setting are determined.

stator. In machinery, a part or assembly that remains stationary with respect to a rotating or moving part or assembly such as the field frame of an electric motor or generator, or the stationary casing and blades surrounding an axial-flow-compressor rotor or turbine wheel; a stator blade.

statute mile. 5280 feet = 1.6093 **kilometers** = 0.869 **nautical mile.** Also called *land mile.*

steady flight. Flight without **accelerations** or **oscillations.**

steady flow. A **flow** whose velocity vector components at any point in the **fluid** do not vary with time. See **streamline flow.**

steady state. 1. The condition of a substance or system whose local physical and chemical properties do not vary with time. **2.** Specifically, the stable operating condition of a **reactor** in which the neutron inventory remains constant; that is, the **effective multiplication factor** k_e is equal to 1.

steady-state problem. See **initial-value problem.**

steady-state vibration. A condition that exists in a **system** if the velocity of each particle is a continuing **periodic quantity.**

steerable antenna. A **directional antenna** whose major **lobe** can be readily shifted in direction.

steering function. An empirical relation based on the **relative** distance and velocity of the target, used in **guidance** of rockets and spacecraft.

Stefan-Boltzmann constant (*symbol* σ). A universal constant of proportionality between the radiant **emittance** of a **black body** and the fourth power of the body's **absolute temperature;** 5.6697×10^{-5} erg per centimeter squared second °K^4.

Stefan-Boltzmann law. One of the **radiation laws** which states that the amount of energy radiated per unit time from a unit surface area of an ideal **black body** is proportional to the fourth power of the **absolute temperature** of the black body. The law is written:

$$E = \sigma T^4$$

where E is the emittance of the black body; σ is the Stefan-Boltzmann constant; and T is the absolute temperature of the black body. Also called *Stefan law.*

This law was established experimentally by Stefan and was given theoretical support by thermodynamic reasoning due to Boltzmann. This law may be deduced by integrating **Planck law** over the entire frequency spectrum.

Stefan law = Stefan-Boltzmann law.

stellar. Of or pertaining to **stars.**

stellarator machine. An experimental **thermonuclear device** where containment in a **magnetic field** is achieved by closing the field upon itself and thus allowing the particles to perform endless spiral motion.

stellar classification. See **star classification.**

stellar guidance = celestial guidance.

stellar inertial guidance. The guidance of a flight-borne vehicle by a combination of **celestial** and **inertial guidance;** the equipment which accomplishes the guidance.

stellar magnitude = magnitude.

stellar map matching. A process during the flight of a **vehicle** by which a chart of the stars set into the **guidance** system is automatically matched with the position of the stars observed through telescopes so as to give guidance to the vehicle. See **map-matching guidance.**

stellar parallax = heliocentric parallax.

stellar scintillation = astronomical scintillation.

St. Elmo's fire = corona discharge.

step rocket = multistage rocket.

steradian. The unit **solid angle** which cuts unit area from the surface of a sphere of unit

radius centered at the vertex of the solid angle. There are 4 π steradians in a sphere.

stereochemistry. Chemistry dealing with the arrangement of atoms and molecules in three dimensions.

sternumward acceleration. See **physiological acceleration.**

stiction = *static* **friction.**

stiffness. The ratio of change of force (or torque) to the corresponding change in translational (or rotational) displacement of an elastic element.

stilb. A unit of **luminance** (or brightness) equal to 1 **international candle** per square centimeter. Compare **apostilb.**

stimulus. **1.** = **excitation.** **2.** = **measurand.**

Stirling cycle. A theoretical **heat engine** cycle in which heat is added at constant volume, followed by **isothermal** expansion with heat addition. The heat is then rejected at constant volume, followed by isothermal compression with heat rejection.

If a regenerator is used so that heat rejected during the constant-volume process is recovered during heat addition at constant volume, the **thermal efficiency** of the Stirling cycle is the same as for the **Carnot cycle**, with less compressive work needed.

stochastic. Conjectural; in statistical analysis, = **random.**

stochastic process. An ordered set of observations in one or more dimensions, each being considered as a sample of one item from a **probability** distribution.

stoichiometric. Of a mixture of chemicals, having the exact proportions required for complete chemical combination, applied especially to combustible mixtures used as **propellants.**

stooping. An **atmospheric refraction** phenomenon, a mirage; a special case of **sinking** in which the curvature of light rays due to atmospheric refraction decreases with elevation so that the visual image of a distant object is foreshortened in the vertical.

The opposite of *stooping* is *towering*.

stopping point. The end of the highly luminous path of a visual **meteor.** Also called *Hemmungspunkt.*

storable. Of a liquid; subject to being placed and kept in a tank without benefit of special measures for temperature or pressure control, as in *storable propellant.*

storage. **1.** The act of storing **information.** See **store.** **2.** Any device in which information can be stored. Also called a *memory device.* **3.** In a **computer,** a section used primarily for storing information. Such a section is sometimes called a *memory* or a *store.*

The physical means of storing information may be electrostatic, ferroelectric, magnetic, acoustic, optical, chemical, electronic, electrical, mechanical, etc., in nature.

storage capacity. The amount of **information,** usually expressed in **bits** (i.e., the $\log_2$ of the number of distinguishable states in which the storage can exist), that can be retained in **storage.** Also called *memory capacity.*

store. **1.** To retain information in a device from which it can later be withdrawn. **2.** To introduce information into such a device. **3.** A container, rocket, bomb, or vehicle carried externally in a craft.

straddle carrier. A ground vehicle that carries its load suspended between its wheels.

strain. The deformation produced by a **stress** divided by the original dimension.

strain gage. An instrument used to measure the **strain** or distortion in a member or test specimen (such as a structural part) subjected to a **force.**

stratosphere. See **atmospheric shell.**

stratosphere radiation. Any **infrared radiation** involved in the complex infrared exchange continually proceeding within the **stratosphere.**

stream. A group of **meteoroids** with nearly identical orbits, also called *meteor stream.*

streamline. A line whose tangent at any point in a **fluid** is parallel to the instantaneous velocity vector of the fluid at that point. The differential equations of the streamlines may be written $dr \times \mathrm{v} = 0$, where dr is an element of the streamline and v is the velocity vector; or in Cartesian coordinates, $dx/\mathrm{u} = dy/\mathrm{v} = dz/\mathrm{w}$, where u, v, w, are the fluid velocities along the orthogonal X, Y, Z axes, respectively.

In steady-state flow the streamlines coincide with the trajectories of the fluid particles; otherwise, the streamline pattern changes with time. See **free streamline.** Compare **trajectory.**

streamline flow = **laminar flow.**

stress. **1.** The **force** per unit area of a body that tends to produce a deformation. **2.** The effect of a physiological, psychological, or mental load on a biological organism which causes fatigue and tends to degrade proficiency.

stress concentration. In structures, a localized area of high **stress.** See **stress raiser.**

stress cycle. A variation of **stress** with time, repeated periodically and identically. See **fatigue.**

stress raisers. Changes in contour or discon-

tinuities in a structure that cause local increases in **stress.**

stress ratio. The ratio of the minimum **stress** to the maximum stress occurring in one **stress cycle.**

stress tensor. The complete set of **stress** components in a solid or fluid medium, which are written as a **tensor** τ_{ij}. It has nine components, one for each of the coordinate faces of an imaginary element upon which the stress acts ($j = x, y, z$) and for each direction in which the stress is directed ($i = x, y, z$).

By definition, an inviscid fluid is one in which the six tangential stresses ($i \neq j$) are zero, and the three normal stresses ($i = j$) are equal to the negative of the pressure.

stretchout. An action whereby the time for completing an action, especially a contract, is extended beyond the time originally programed or contracted for.

strewn field. See **tektite.**

stringer. A slender, lightweight, lengthwise fill-in structural member in a rocket body, or the like, serving to reinforce and give shape to the skin.

Strouhal number (*symbol* N_{Str}). A nondimensional number occurring in the study of **periodic** or quasiperiodic variations in the wake of objects immersed in a **fluid** stream:

$$N_{Str} = nl/u$$

where n is a frequency; l is a representative length, and u is a representative velocity of the stream.

structural weight = construction weight.

subassembly. An **assembly** that is a component part of a larger assembly.

subastral point = substellar point.

subatomic particle. Any **particle** of less than atomic mass, e.g., the electron, proton, and neutron, also called *atomic particle.*

Subatomic particles are classified by relative mass into four groups: leptons, mesons, nucleons, and hyperons, from lowest to highest masses, respectively.

subaudio frequency. A **frequency** below the **audiofrequency range,** below about 15 cycles per second.

subcarrier. A **carrier** which is applied as a **modulating wave** to modulate another carrier or an intermediate subcarrier.

subcarrier oscillator. In a **telemetry** system, the **oscillator** which is directly modulated by the **measurand** or by the equivalent of the measurand in terms of changes in the transfer elements of a **transducer.**

subchannel. In a **telemetry** system, the route required to convey the **magnitude** of a single subcommutated **measurand.**

subcommutation. In **telemetry, commutation** of additional **channels** with output applied to individual channels of the primary **commutator.**

Subcommutation is called *synchronous* if its rate is a submultiple of that of the primary commutator. Unique identification must be provided for the subcommutation frame pulse.

subframe. In telemetry, a complete sequence of **frames** during which all subchannels of a specific **channel** are sampled once.

subgravity. A condition in which the **acceleration** acting on a body is less than normal **gravity,** between 0 and 1 g.

subharmonic. A **sinusoidal** quantity having a **frequency** that is an integral submultiple of the **fundamental frequency** of a **periodic quantity** to which it is related.

sublimation. The transition of a substance directly from the solid state to the vapor state, or vice versa, without passing through the intermediate liquid state. See **condensation, evaporation.**

subliming ablator. An **ablation material** characterized by **sublimation** of the material at the heated surface.

sublunar point. The **geographical position** of the moon; that point on the earth at which the moon is in the **zenith** at a specified time.

subpermanent magnetism = permanent magnetism.

The expression *subpermanent magnetism* is sometimes used because of the slow dissipation of such magnetism, but the expression *permanent magnetism* is considered preferable.

subrefraction. Less-than-normal **refraction,** particularly as related to **atmospheric refraction.**

Greater-than-normal refraction is called *superrefraction.*

subroutine. A set of instructions necessary to direct a computer to carry out a well-defined mathematical or logical operation; a subunit of a **routine,** usually coded in such a manner that it can be treated as a **black box** by the routine using it.

subsatellite point. Intersection of the **local vertical** passing through a **satellite** in orbit with the earth's surface.

subsolar point. The **geographical position** of the sun; that point on the earth at which the sun is in the **zenith** at a specified time.

subsonic. In aerodynamics, of or pertaining to, or dealing with speeds less than **acoustic velocity** as in *subsonic aerodynamics.*

subsonic flow. Flow of a **fluid,** as air over an airfoil, at speeds less than **acoustic velocity.**

Aerodynamic problems of subsonic flow are treated with the assumption that air acts as an incompressible fluid.

substandard propagation. The **propagation** of radio energy under conditions of substandard refraction in the atmosphere, that is, refraction by an atmosphere or section of the atmosphere in which the **index of refraction** decreases with height at a rate of less than 12 N-units per 1000 feet. See **standard propagation, superstandard propagation.**

Substandard propagation produces a less-than-normal downward bending or even an upward bending of radio waves as they travel through the atmosphere, giving closer radio horizons and decreased radar and radio coverage. It results primarily when propagation takes place through a layer in which moisture remains constant or increases with height.

substandard refraction. Also called *subrefraction.* See **substandard propagation.**

substantial derivative = individual derivative.

substellar point. The **geographical position** of a star; that point on the earth at which the star is in the **zenith** at a specified time. Also called *subastral point.*

substratosphere. Loosely and nontechnically, the very high **troposphere.**

subtend. To be opposite, as *an arc of a circle subtends an angle at the center of the circle,* the angle being formed by the radii joining the ends of the arc with the center.

sudden-commencement magnetic storm. A magnetic storm characterized by a world-wide sudden commencement which takes place in a matter of minutes and shows no recurrence after 27 days, the period of rotation of the sun.

sudden ionospheric disturbance (*abbr* **SID**). A complex combination of sudden changes in the condition of the **ionosphere** and the effects of these changes.

The following are the most important effects accompanying a sudden ionospheric disturbance: (**a**) radio fadeout, a condition in which there is a marked and abrupt increase in absorption in the D-region for high-frequency radio waves (2 to 3 megacycles) and a consequent loss of long-distance radio reception in this range of frequencies; (**b**) magnetic crotchet, a sudden change in the earth's magnetic field due to an increase in the conductivity of the lower ionosphere, the change being in the nature of an augmentation of the normal quiet-day magnetic change; (**c**) sudden enhancements of long-wave atmospherics recorded in the frequency range between 10 and 100 kilocycles due to the improved reflectivity at oblique incidence of the D-region for such low-frequency radio waves; (**d**) sudden phase anomalies of discrete low-frequency radio waves (10 to 100 kilocycles) due to descent of the D-layer; and (**e**) sudden field-strength anomalies of distant low-frequency radio signals (10 to 100 kilocycles) due to interference between the groundwave and the skywave.

A sudden ionospheric disturbance usually occurs a few minutes after a solar flare and is noted only on the sunlit side of the earth. The return of the ionosphere to its *normal* condition following a pronounced sudden ionospheric disturbance usually takes from half an hour to an hour, sometimes longer.

summer solstice. 1. That point on the **ecliptic** occupied by the sun at maximum northerly declination. Sometimes called *June solstice, first point of Cancer.* **2.** That instant at which the sun reaches the point of maximum northerly **declination,** about June 21.

sun. The star at the center of the **solar system,** around which the planets, planetoids, and comets revolve. It is a G-type star.

The sun visible in the sky is called *apparent* or *true* sun. A fictitious sun conceived to move eastward along the celestial equator at a rate that provides a uniform measure of time equal to the average apparent time is called *mean sun*; a fictitious sun conceived to move eastward along the ecliptic at the average rate of the apparent sun is called *dynamical mean sun.*

sunrise. The crossing of the visible **horizon** by the **upper limb** of the ascending sun.

sunset. The crossing of the visible **horizon** by the **upper limb** of the descending sun.

sunspot. A relatively dark area on the surface of the sun consisting of a dark central umbra surrounded by a penumbra which is intermediate in brightness between the umbra and the surrounding **photosphere.** See **relative sunspot number.**

Sunspots usually occur in pairs with opposite magnetic polarities. They have a lifetime ranging from a few days to several months. Their occurrence exhibits approximately an 11-year period (the **sunspot cycle**).

sunspot cycle. A cycle with an average length of 11.1 years but varying between about 7 and 17 years in the number and area of **sunspots,** as given by the **relative sunspot number.** This number rises from a minimum of 0 to 10 to a maximum of 50 to 140 about 4 years later, and then declines more slowly.

An approximate 11-year cycle has been found or suggested in geomagnetism, frequency of aurora, and other ionospheric characteristics. The u-index of geomagnetic intensity variation shows one of the strongest known correlations to solar activity.

Eleven-year cycles have been suggested for various tropospheric phenomena, but none of these has been substantiated.

sunspot number. See **relative sunspot number.**

sunspot relative number = relative sunspot number.

sun's way. The path of the **solar system** through **space.** See **solar apex.**

sun tracker. A species of **star tracker** designed to lock onto the sun to afford **guidance** to a rocket or other flight-borne object. See **star tracker.**

superadiabatic lapse rate. An environmental **lapse rate** greater than the **dry-adiabatic lapse rate,** such that potential temperature decreases with height.

superalloy. An alloy developed for very high temperature service where relatively high stresses (tensile, thermal, vibratory, and shock) are encountered and where oxidation resistance is frequently required.

supercommutation. Commutation by connection of single data input source to equally spaced contacts of the **commutator** (crosspatching).

Corresponding crosspatching is required at the decommutator.

super high frequency (*abbr* SHF). See **frequency bands.**

superior conjunction. The **conjunction** of a planet and the sun when the sun is between the earth and the other planet.

superior mirage. A spurious image of an object formed above its true position by abnormal **atmospheric refraction** conditions; opposite to an **inferior mirage.** Compare **towering, looming, inferior image.**

Superior mirages occur when the temperature lapse rate near the earth's surface is less than its normal value or, especially, when the temperature actually increases with height. Under these conditions the velocity of light increases upward in such a way that light rays are bent downward as they propagate through the layer in quasi-horizontal directions. The downward curvature gives the impression that the position of the object viewed is well above its true position in space. The object also appears inverted. Complex combinations of superior and inferior mirages may occur with unusual density stratifications.

superior planets. The **planets** with **orbits** larger than that of the earth: Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

superior transit = upper transit.

superpressure balloon. See **constant-level balloon,** note.

superrefraction = superstandard refraction.

supersonic. Of or pertaining to, or dealing with, speeds greater than the **acoustic velocity.** Compare with **ultrasonic.**

supersonic compressor. A **compressor** in which a **supersonic** velocity is imparted to the fluid relative to the **rotor** blades, the **stator** blades, or to both the rotor and stator blades, producing oblique **shock waves** over the blades to obtain a high pressure rise.

supersonic diffuser. A **diffuser** designed to reduce the velocity and increase the pressure of **fluid** moving at **supersonic** velocities.

supersonic flow. In aerodynamics, flow of a **fluid** over a body at speeds greater than the **acoustic velocity** and in which the **shock waves** start at the surface of the body. Compare **hypersonic flow.**

supersonic nozzle. A converging-diverging **nozzle** designed to accelerate a **fluid** to **supersonic** speed.

supersonics. Specifically, the study of **aerodynamics** of **supersonic** speeds. See **hypersonics.**

superstandard propagation. The **propagation** of radio waves under conditions of superstandard refraction (superrefraction) in the atmosphere, that is, **refraction** by an atmosphere or section of the atmosphere in which the **index of refraction** decreases with height at a rate of greater than 12 N-units per 1000 feet. See **standard propagation, substandard propagation.**

Superstandard propagation produces a greater-than-normal downward bending of radio waves as they travel through the atmosphere, giving extended radio horizons and increased radar coverage. It results primarily from propagation through layers near the earth's surface in which the moisture lapse rate is greater than normal, or the temperature lapse rate less than normal, or both. A condition in which warm dry air moves out over a cool water surface is an example of superrefraction.

A layer in which the downward bending is greater than the curvature of the earth is called a *radio duct.*

Frequently, the general term, *anomalous propagation,* is used for superstandard propagation.

superstandard refraction. Refraction by an atmosphere or section of the atmosphere in which the **index of refraction** decreases with height at a rate greater than 12 N-units per 1000 feet. Also called *superrefraction.*

supplement. An angle equal to 180° minus a given angle. Thus 110° is the supplement of 70° and the two are said to be *supplementary.* See **complement, explement.**

supplementary angles. Two angles whose sum is 180°.

support equipment. See **ground support equipment.**

surface. 1. A two-dimensional extent; the outside or superficies of any body; especially, the surface of the earth, either land or water, used in combinations as surface-to-air, etc. **2.** A wing, rudder, propeller blade, vane, hydrofoil, or the like—applied in this sense to the entire structure or body.

surface boundary layer. That thin layer of air adjacent to the earth's surface, extending up to the so-called anemometer level (the base of the **Ekman layer**). Within this layer the wind distribution is determined largely by the vertical temperature gradient and the nature and contours of the underlying surface; shearing stresses are approximately constant. Also

called *surface layer*, *friction layer*, *atmospheric boundary layer*, *ground layer*. See **logarithmic velocity profile, planetary boundary layer, free atmosphere.**

surface duct. An **atmospheric duct** for which the lower boundary is the surface of the earth.

surface layer = surface boundary layer.

surface of position. A surface on some point of which a craft is located. See **line of position, fix.**

surge. A transient rise in power, pressure, etc., such as a brief rise in the discharge pressure of a rotary compressor.

survey. The process of determining accurately the position, extent, contour, etc., of an area, usually for the purpose of preparing a chart.

suspended phase. See **suspension.**

suspension. In physical chemistry, a **system** composed of one substance (suspended phase, suspensoid) dispersed throughout another substance (suspending phase) in a moderately finely divided state, but not so finely divided as to acquire the stability of a **colloidal system.**

Given sufficient time, a suspension will, by definition, separate itself by gravitational action into two visibly distinct portions, whereas a colloidal system, by definition, is stable.

Dust in the atmosphere is an example of a suspension of a solid in a gas.

suspensoid. See **suspension.**

sustainer. Anything that acts to sustain an action or movement already begun; specifically, a **sustainer engine.**

sustainer engine. A **rocket engine** that maintains the velocity of a rocket vehicle once it has achieved its programed velocity by use of **booster** or other engine.

This term is applied, for example, to the remaining engine of the Atlas after the two booster engines have been jettisoned. The term is also applied to a rocket engine used on an orbital glider to provide the small amount of thrust now and then required to compensate for the drag imparted by air particles in the upper atmosphere.

sweat cooling = transpiration cooling.

sweep. The motion of the visible dot across the face of a **cathode-ray tube,** as a result of deflections of the **electron beam.**

A linear time-base sweep has a constant sweep speed before retrace. An expanded time-base sweep is produced if the sweep speed is increased during a selected part of the cycle; a delayed time-base sweep if the start of the sweep is delayed, usually to provide an expanded scale for a particular part. A sweep intended primarily for measurement of range may be called a *range sweep.* See **trace.**

swing-around trajectory. A planetary round trip **trajectory** which requires no propulsion at the destination planet, but uses the planet's **gravitational** field to effect the necessary orbit change to return to earth.

synchrocyclotron. A **cyclotron** in which the frequency of the electric field is **frequency modulated** to permit the acceleration of particles to **relativistic** energies. Also called *FM cyclotron.*

synchronism. The relationship between two or more **periodic quantities** of the same **frequency** when the **phase** difference between them is zero or constant at a predetermined value.

synchronous. Coincident in time, phase, rate, etc.

synchronous computer. A **computer** in which the starting time of every ordinary operational cycle is controlled by **signals** which occur at regular intervals. Contrast with **asynchronous computer.**

synchronous satellite. An equatorial west-to-east **satellite** orbiting the earth at an altitude of approximately 35,900 kilometers at which altitude it makes one **revolution** in 24 hours, synchronous with the earth's **rotation.**

synchrotron. A device for accelerating **particles,** ordinarily **electrons,** in a circular orbit in an increasing **magnetic field** by means of an alternating **electric field** applied in synchronism with the orbital motion.

synergic ascent. The ascent of a rocket vehicle along a **synergic curve.**

synergic curve. A curve plotted for the ascent of a **rocket vehicle** calculated to give the vehicle an optimum economy in fuel with an optimum velocity.

This curve, plotted to minimize air resistance, starts off vertically, but bends towards the horizontal between 20 and 60 miles altitude to minimize the thrust required for vertical ascent.

synodical month. The average period of **revolution** of the moon about the earth with respect to the sun, a period of 29 days 12 hours 44 minutes 2.8 seconds.

This is sometimes called the *month of the phases,* since it extends from new moon to the next new moon. Also called *lunation.*

synodic period. The interval of time between any **planetary configuration** of a **celestial body,** with respect to the sun, and the next successive same configuration of that body, as from **inferior conjunction** to inferior conjunction.

synodic satellite. A hypothetical earth **satellite,** situated 0.84 of the distance to the moon on a line joining the centers of the earth and moon and having the same period of **revolution** as the moon.

synoptic. Pertaining to or affording an overall view.

In meteorology, this term refers to meteorological data obtained simultaneously over a wide area for the purpose of presenting a comprehensive and nearly instantaneous picture of the state of the atmosphere. Thus, to a meteorologist, *synoptic* takes on the additional connotation of simultaneity.

synoptic correlation = Eulerian correlation.

synoptic meteorology. The study and analysis of weather information gathered at the same time. See **synoptic.**

syntony. The situation of two or more oscillating **circuits** having the same **resonance frequency.**

system. **1.** Any organized arrangement in which each component part acts, reacts, or interacts in accordance with an overall design inherent in the arrangement. **2.** Specifically, a major component of a given **vehicle** such as a *propulsion system* or a *guidance system.* Usually called a *major system* to distinguish it from the systems subordinate or auxiliary to it.

The system of sense **1** may become organized by a process of evolution, as in the solar system, or by deliberate action imposed by the designer, as in a missile system or an electrical system.

In sense **2**, the system embraces all its own subsystems including checkout equipment, servicing equipment, and associated technicians and attendants. When the term is preceded by such designating nouns as *propulsion* or *guidance*, it clearly refers to a major component of the missile. Without the designating noun, the term may become ambiguous. When modified by the word *major*, however, it loses its ambiguity and refers to a major component of the missile.

systematic error. An **error** that is always a function of the **magnitude** of the **quantity** observed.

When the error is constant it is called a *bias error.* Systematic errors are often caused by false elements in an instrument. An example is an eccentrically mounted azimuth circle or an azimuth circle with graduation errors.

system of astronomical constants. An interrelated group of values constituting a model of the earth and the motions which together with the theory of **celestial mechanics** serves for the calculation of **ephemerides.** See **astronomical constants,** note and tables II and III.

syzygy. A point of the **orbit** of a planet or satellite at which it is in **conjunction** or **opposition.**

The term is used chiefly in connection with the moon, when it refers to the points occupied by the moon at new and full phase.

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T

Tacan (*abbr*) = **tactical air navigation.**

tachycardia. Very rapid beating of the heart.

tactical air navigation (*abbr* **Tacan**). A two-dimensional navigation system which provides **azimuth** and distance to a fixed ground station for navigation in piloted aircraft.

Distance is determined by pulse interrogation of the ground station with time comparison to the returned pulse. Azimuth is provided by comparison of a continuous-wave audiosignal from pulse amplitudes to reference pulses.

tail. **1.** The rear part of a body, as of an aircraft, a rocket, etc. **2.** The tail surfaces of an aircraft or rocket.

tail fin. A **fin** at the rear of a **rocket** or other body.

tailward acceleration. See **physiological acceleration.**

take-off. **1.** The action of a **rocket vehicle** departing from its **launch pad.** See **lift-off** **2.** The action of an aircraft as it becomes airborne. **3.** To perform the action of a take-off. Said of a rocket vehicle or aircraft.

tandem launch. The launching of two or more **satellites** using a single **launch vehicle.**

tangential acceleration. The **acceleration** acting at the periphery of a system rotating about an axis.

tangential wave path. For a direct **radio wave,** that path of **propagation** tangential to the surface of the earth. This path is curved slightly by **atmosphere refraction.**

tangent ogive. An **ogive** whose circular-arc contours have their centers on a line normal to the axis at the base of the ogive, the arcs thus being tangent to the surface of the cylindrical body behind the ogive. See **ogive.**

tank. **1.** A container incorporated into the structure of a **liquid propellant rocket** from which a liquid **propellant** or propellants are fed into the firing chamber or chambers. **2.** A container for storage of liquid oxygen, liquid fuel, or other liquid propellant until transferred to the rocket's tanks or some other receptacle. **3.** In **computers,** a container of mercury, or other liquid, and associated components used as **delay-line** storage.

tankage. Of a **liquid propellant rocket,** the aggregate of the **tanks** carried by the rocket.

Tare (*abbr*) = **telemetry automatic reduction system.**

target. **1.** Any object, point, etc., toward which something is directed. **2.** An object which reflects a sufficient amount of a radiated signal to produce an **echo** signal on detection equipment. See **radar target.**

target acquisition. The process of optically, manually, mechanically, or electronically orienting **tracking** system in direction and range to **lock on** a target.

target board. A board usually painted in a distinctive pattern, having a known geometrical relationship to a camera, and used for determining the orientation of that camera.

target discrimination. **Resolution** of a **radar.**

target glint = **scintillation.**

target signal. The radar **energy** returned to a **radar** by a **target.** Also called *echo signal, video signal.*

The amount of this energy is termed *received power.*

Tau, Taur. International Astronomical Union abbreviations for Taurus. See **constellation.**

Taurus (*abbr* **Tau, Taur**). See **constellation.**

Taylor number (*symbol* N_{Ta}). A nondimensional number arising in problems of a rotating **viscous** fluid. It may be written

$$N_{Ta} = f^2h^4/\nu^2$$

where f is the coriolis parameter (or, for a cylindrical system, twice the rate of rotation of the system); h represents the depth of the fluid; and ν is the kinematic viscosity. The square root of the Taylor number is a **rotating Reynolds number,** and the fourth root is proportional to the ratio of the depth h to the depth of the **Ekman layer.**

Taylor series. See **Taylor theorem.**

Taylor theorem. **1.** If all the derivatives of a function $f(x)$ are continuous in the vicinity of $x = a$, then $f(x)$ can be expressed in an infinite series (the Taylor series):

$$f(x) = f(a) + f'(a)(x-a) + \frac{1}{2!}f''(a)(x-a)^2 + \ldots + \frac{1}{n!}f^{(n)}(a)(x-a)^n$$

The case $a = 0$ is called a *Maclaurin series.* **2.** The theorem of G. I. Taylor in the **statistical** theory of atmospheric turbulence:

$$\overline{x^2} = 2\overline{u^2}\int_0^T\int_0^t R(\xi)\, d\xi\, dt$$

where x is the distance traveled by a particle in the time interval T; u is the fluctuation or eddy velocity of the particle; and $R(\xi)$ is the Lagrangian correlation coefficient between the particle's velocity at time t and $t + \xi$.

teardrop balloon. A **sounding** balloon which, when operationally inflated, resembles an inverted teardrop. This shape was determined primarily by aerodynamic considerations of the problem obtaining maximum stable rates of balloon ascension.

technical photography. The recording of photographic images for information relevant to some engineering phenomena of a qualitative nature.

technical sequential photography. Slow or rapid sequence photography serving the study of event occurrence, or duration, by the adjunct of time coordinates recorded on the film simultaneously with the event.

tektite. Small glassy bodies containing no crystals, composed of at least 65 percent silicon dioxide, bearing no relation to the geological formations in which they occur, and believed to be of extraterrestrial origin.

Tektites are found in certain large areas called *strewn fields*. They are named, as are minerals, with the suffix *ite*, as *australite*, found in Australia, *billitonite*, *indochinite*, and *rizalite*, found in Southeast Asia, *bediasite* from Texas, and *moldavite* from Bohemia and Moravia.

Tel, Tele. International Astronomical Union abbreviations for *Telescopium*. See **constellation.**

telefork. A ground support vehicle that serves as a tractor, a forklift, and a crane.

telemeter. **1.** To measure at a distance. See **telemetering, telemetry.** **2.** The electronic unit which transmits the **signal** in a telemetering system.

telemetering. **1.** A measurement accomplished with the aid of intermediate means which allows perception, recording, or interpretation of data at a distance from a primary **sensor.**

The most widely employed interpretation of telemetering restricts its significance to data transmitted by means of electromagnetic propagation.

2. Automatic radio **communication** intended to indicate or record a measurable variable quantity at a distance.

telemetry. The science of measuring a quantity or quantities, transmitting the results to a distant station, and there interpreting, indicating, and/or recording the quantities measured.

telemetry elsse. An **elsse** which utilizes the **telemetry** transmitter as a **signal** source.

telephotometer. A **photometer** that measures the received **intensity** of a distant light source. When specifically used to measure the **transmissivity** of the intervening atmosphere (or other medium), it is usually termed a *transmissometer*. See **visibility meter.**

telephotometry. The body of principles and techniques concerned with measuring atmospheric **extinction** using various types of **telephotometer.**

Telescopium (*abbr* **Tel, Tele**). See **constellation.**

telluric lines. **Absorption lines** in a solar spectrum produced by constituents of the atmosphere of the earth itself rather than by gases in the outer solar atmosphere such as those responsible for the Fraunhofer lines.

The terrestrial nature of the absorption processes responsible for telluric lines is revealed by their intensity variation with solar zenith angle and by their freedom from any Doppler broadening due to their solar rotation. Water vapor produces the strongest of the telluric lines in the visible spectrum.

temperature. **1.** In general, the **intensity** of **heat** as measured on some definite temperature scale by means of any of various types of thermometers. **2.** In statistical mechanics, a measure of translational molecular **kinetic energy** (with three degrees of freedom). **3.** In thermodynamics, the integrating factor of the differential equation referred to as the **first law of thermodynamics.**

tensor. An **array** of functions which obeys certain laws of transformation. A one-row or one-column tensor array is a vector.

The motivation for the use of tensors in some branches of physics is that they are invariants, not depending on the particular coordinate system employed.

tera (*abbr* **T**). A prefix meaning multiplied by 10^{12}.

teracycle = 1000 gigacycles.

tercentesimal thermometric scale = approximate absolute temperature scale.

terminal. **1.** A point at which any **element** in a **circuit** may be directly connected to one or more other elements. **2.** Pertaining to a final condition or the last division of something, as *terminal ballistics.*

terminal ballistics. That branch of **ballistics** dealing with the motion and behavior of **projectiles** at the termination of their flight, or in striking and penetrating a target.

terminal guidance. **Guidance** from an arbitrary point, at which **midcourse guidance** ends, to the destination.

terminal velocity. The maximum velocity attainable, especially by a freely falling body, under the given conditions.

terminator. The line separating illuminated

and dark portions of a celestial body, as the moon, which is not self luminous.

ternary notation. A system of **positional notation** using 3 as a base.

terrestrial. Of or pertaining to the earth.

terrestrial coordinates = geographical coordinates.

terrestrial equator = astronomical equator.

terrestrial latitude. Latitude on the earth; angular distance from the **equator.** See **coordinate,** table VI.

Terrestrial latitude is named for the datum used to measure angular distance from the equator. *Astronomical latitude* is the angular distance between the direction of gravity and the plane of the equator. *Geodetic* or *topographical latitude* is the angular distance between the plane of the equator and a normal to the spheroid. *Geodetic* and sometimes *astronomical* latitude are also called *geographic latitude. Geocentric latitude* is the angle between a line to the center of the earth and the plane of the equator. *Geodetic latitude* is used for charts.

terrestrial longitude. Longitude on the earth; the arc of a **parallel,** or the angle at the pole, between the **prime meridian** and the meridian of a point on the earth. See **coordinate,** table VI.

Terrestrial longitude is named for the datum used to measure it. *Astronomical longitude* is the angle between the plane of the reference meridian and the plane of the celestial meridian. *Geodetic longitude* is the angle between the plane of the reference meridian and the plane through the polar axis and the normal to the spheroid. *Geodetic* and sometimes *astronomical longitude* are also called *geographic longitude. Geodetic longitude* is used for charts.

terrestrial magnetism. The magnetism of the earth. Also called *geomagnetism.*

terrestrial meridian = astronomical meridian.

terrestrial pole. One of the poles of the earth. See **geographical pole, geomagnetic pole, magnetic pole.**

terrestrial radiation. 1. The total **infrared** radiation emitted from the earth's surface; to be carefully distinguished from **effective terrestrial radiation, atmospheric radiation** (which is sometimes erroneously used as a synonym for terrestrial radiation), and **insolation.** Also called *earth radiation, eradiation.*

terrestrial-reference guidance. See **guidance,** note.

terrestrial refraction. 1. Any **refraction** phenomenon observed in the light originating from a source lying within the earth's atmosphere; as contrasted to **astronomical refraction,** sense **2.**

This is applied only to refraction caused by inhomogeneities of the atmosphere itself, not, for example, to that caused by ice crystals suspended in the atmosphere. Terrestrial refraction is responsible for such phenomena of meteorological optics as looming, sinking, stooping, towering, mirages, and terrestrial scintillation.

2. = terrestrial refraction error.

terrestrial refraction error. The angular **refraction** error, for a ground observer, of an object in the vicinity of the earth. Also called *terrestrial refraction.*

terrestrial scintillation. Generic term for **scintillation** phenomena observed in light that reaches the eye from sources lying within the earth's atmosphere; to be differentiated from **astronomical scintillation** which is observed in light from extraterrestrial sources such as stars. Also called *atmospheric boil, atmospheric shimmer, shimmer, optical haze.*

Terrestrial scintillation is produced by irregular refraction effects due to passage, across the line of sight, of air parcels (schlieren) whose densities differ slightly from that of their surroundings. Density irregularities with dimensions of the order of centimeters, or at most decimeters, are responsible for most such scintillatory effects.

tesla (*abbr* **T**). The unit of **magnetic flux density,** one **weber** per square **meter.**

terrestrial triangle. See **navigational triangle.**

test. 1. A procedure or action taken to determine under real or simulated conditions the capabilities, limitations, characteristics, effectiveness, reliability, or suitability of a material, device, system, or method. **2.** A similar procedure or action taken to determine the reactions, limitations, abilities, or skills of a person, other animal, or organism.

test bed. 1. A base, mount, or frame within or upon which a piece of equipment, especially an **engine,** is secured for testing. **2.** A flying test bed.

test chamber. A place, section, or room having special characteristics where a person or object is subjected to experiment, as *an altitude chamber;* specifically, the **test section** of a **wind tunnel.**

test firing. The **firing** of a **rocket engine,** either live or static, with the purpose of making controlled observations of the engine or of an engine component.

test flight. A **flight** to make controlled observations of the operation or performance of an aircraft or rocket, of an aircraft or rocket component, of a system, etc.

test section. The section of a **wind tunnel** where objects are tested to determine their aerodynamic characteristics. Also called a *test chamber.*

test stand. A stationary platform or table, together with any testing apparatus attached

thereto, for testing or proving engines, instruments, etc. See **proving stand.** Compare **launch stand.**

Tethys. A **satellite** of Saturn orbiting at a mean distance of 295,000 kilometers.

theodolite. An optical instrument which consists of a sighting telescope, mounted so that it is free to rotate around horizontal and vertical axes, and graduated scales so that the angle of **rotation** may be measured. The telescope is usually fitted with a right-angle prism so that the observer continues to look horizontally into the eyepiece, whatever the variation of the **elevation** angle.

theoretical rocket = ideal rocket.

thermal. 1. Of or pertaining to **heat** or **temperature. 2.** A vertical air current caused by differential heating of the terrain.

thermal accommodation coefficient = accommodation coefficient.

thermal barrier. A popular term for speed limitations within an atmosphere imposed by **aerodynamic heating.** Also called the *heat barrier.*

thermal conductivity. An intrinsic physical property of a substance, describing its ability to conduct heat as a consequence of molecular motion. The thermal conductivity bears the same relation to the conduction of heat as the dynamic viscosity does to the transfer of momentum. It can be defined by reference to the Newton law of cooling:

$$H = -k(\partial T/\partial N)$$

where k is the thermal conductivity; H the rate of heat conduction across a surface per unit area and per unit time; and $\partial T/\partial N$ the temperature gradient normal to the surface. Also called *heat conductivity, coefficient of thermal conduction, coefficient of heat conduction.*

thermal conductivity vacuum gage. A **vacuum gage** containing two surfaces at different temperatures between which heat can be transported by the gas molecules so that changes in the temperature (or in the heating power required to maintain constant temperature) of one of the surfaces can be correlated with the gas pressure by calibration against a **McLeod gage.**

Various types of thermal conductivity gages are distinguished according to the method of indicating the temperature change. The common types are: Pirani gage; thermocouple gage; thermistor gage; bimetallic strip gage.

thermal efficiency. 1. The **efficiency** with which a **heat engine** transforms the potential heat of its fuel into work or output, expressed as the ratio of the useful work done by the engine in a given time interval to the total heat energy contained in the fuel burned during the same time interval, both work and heat being expressed in the same units. **2. = thermodynamic efficiency.**

thermal emission. The process by which a body emits **electromagnetic radiation** as a consequence of its temperature only.

thermal emissive power. The rate of **thermal emission** of radiant energy per unit area of emitting surface. Also called *emissive power.*

thermal excitation. In a gas, the **translational energy.**

thermal fatigue. In metals, fracture resulting from the presence of temperature gradients which vary with time in such a manner as to produce cyclic **stresses** in a structure.

thermal instability. The conditions of temperature **gradient, thermal conductivity,** and **viscosity** which lead to the onset of **convection** in a fluid.

Such gross phenomena as atmospheric winds are an example of this type of instability. In general, if the fluid is conducting, as a plasma, the application of a magnetic field tends to reduce these thermal instabilities.

thermal jet engine. A **jet engine** that utilizes heat to expand gases for rearward ejection. This is the usual form of aircraft jet engine.

thermal motions. See **Doppler broadening.**

thermal noise. The **noise** at **radio frequencies** caused by thermal agitation in a dissipative body. Also called *Johnson noise.*

thermal radiation. The **electromagnetic radiation** emitted by any substance as the result of the **thermal** excitation of its molecules. Thermal radiation ranges in wavelength from the longest infrared radiation to the shortest ultraviolet radiation.

thermal shock. The development of a steep temperature **gradient** and accompanying high **stresses** within a structure.

thermal stresses. Stresses in metal, resulting from nonuniform temperature distribution.

thermal tide. A variation in **atmospheric pressure** due to the daily differential heating of the atmosphere by the sun; so-called in analogy to the conventional **gravitational** tide. See **solar atmospheric tide.**

thermal transpiration. The passage of **gas** through a connection between two vessels at different temperatures resulting in a pressure **gradient** when equilibrium is reached.

Under conditions of molecular flow the equilibrium condition is expressed by

$$p_a/p_b = \sqrt{T_a/T_b}$$

where p_a and T_a are the pressure and absolute temperature, respectively, in one vessel and p_b and T_b are the pressure and absolute temperature, respectively, in the other.

thermionic. Of or pertaining to the emission of **electrons** by **heat.**

thermionic cathode = hot cathode.

thermionic conversion. The process whereby **electrons** released by **thermionic emission** are collected and utilized as electric current.

The simplest example of this is provided by a vacuum tube, in which the electrons released from a heated anode are collected at the cathode or plate. Used as a method of producing electrical power for spacecraft.

thermionic emission. Direct ejection of **electrons** as the result of heating the material, which raises electron energy beyond the **binding energy** that holds the electron in the material.

thermionic tube. An **electron tube** in which one or more of the **electrodes** is heated to cause electron or ion **emission.**

thermistor. An **electron device** employing the temperature-dependent change of resistivity of a **semiconductor.**

thermochemical. Pertaining to a chemical change induced by **heat.**

thermochemistry. A branch of chemistry that treats of the relations of **heat** and chemical changes.

thermocouple. A device which converts **thermal** energy directly into **electrical** energy. In its basic form it consists of two dissimilar metallic electrical conductors connected in a closed loop. Each junction forms a thermocouple. See **thermopile.**

If the junctions are at different temperatures, an electrical potential proportional to the temperature difference will exist in the circuit; the value of the potential generated is different for various combinations of materials. For meteorological purposes couples of copper and constantan are frequently used; these generate approximately 40 microvolts per °C of couple temperature difference.

thermocouple gage. A **thermal conductivity vacuum gage** in which pressure change is sensed by a **thermocouple** in thermal contact with a heated filament which cools as pressure rises. Compare with **Pirani gage.**

thermodynamic. Pertaining to the flow of **heat** or to **thermodynamics.**

thermodynamic efficiency. In thermodynamics, the ratio of the work done by a **heat engine** to the total **heat** supplied by the heat **source.** Also called *thermal efficiency*, *Carnot efficiency*.

thermodynamic energy equation. The mathematical statement of the concept of **conservation of energy** embodied in the **first law of thermodynamics.** For reversible processes of a perfect gas, it may be written in the form

$$pQ = \rho c_v\ (dT/dt) - (p/\rho)\ (d\rho)\ (dt)$$

where pQ is the rate of energy addition per unit volume by heating (including the effects of radiation, molecular conduction, condensation of water vapor, and the generation of heat by friction); T is the Kelvin temperature; c_v is the specific heat at constant volume; p is pressure; and ρ is density. See **energy equation.**

thermodynamic equilibrium. A very general result from statistical mechanics which states that if a system is in equilibrium, all processes which can exchange energy must be exactly balanced by the reverse process so that there is no net exchange of energy.

For instance, ionization must be balanced by recombination, bremsstrahlung by absorption, etc. If a plasma complies with this statement, the distribution function of particle energies and excited energy levels of the atoms can be obtained from the Maxwell-Boltzmann distribution which is a function only of the temperature.

thermodynamic function of state. Any of the quantities defining the thermodynamic state of substance in **thermodynamic equilibrium.** Also called *thermodynamic variable*, *state variable*, *state parameter*.

For a perfect gas, pressure, temperature, and density are the fundamental thermodynamic variables, any two of which are, by the **equation of state,** sufficient to specify the state. Quantities defined in terms of these, such as specific volume, potential temperature, etc., may also be used as thermodynamic functions of state. If the composition of the gas varies, this must be specified. Thus, some measure of water vapor is a thermodynamic function of state of the atmosphere.

thermodynamic potential = Gibbs function.

thermodynamic probability. Under specified conditions, the number of equally likely states in which a substance may exist. The thermodynamic probability P is related to the entropy S by

$$S = k \ln P$$

where k is Boltzmann constant. See **third law of thermodynamics.**

thermodynamics. The study of the **flow** of **heat.**

thermodynamic temperature scale. The **Kelvin temperature scale** or the **Rankine temperature scale.**

thermodynamic variable = thermodynamic function of state.

thermogravimetric analysis. The technique of studying materials by observing weight changes caused by chemical reactions that occur when heat is applied.

thermometer. A device for measuring **temperature.**

thermonuclear. Pertaining to a **nuclear** reaction which is triggered by particles of high **thermal** energy.

thermopile. 1. A **transducer** for converting **thermal** energy directly into **electrical** energy, composed of pairs of **thermocouples** which are connected either in series or in parallel. See **Moll thermopile, Eppley pyrheliometer. 2.** A battery of thermocouples connected in series to form a single compact unit.

The output voltage of N pairs of series-connected thermocouples is N times the voltage developed by a single pair, whereas the current developed by N pairs of parallel-connected thermocouples is N times the current developed by a single pair. Thermopiles are used in thermoelectric radiation instruments when the output of a single pair of thermocouples is not large enough.

thermosphere. See **atmospheric shell.**

thermoswitch. A temperature-activated switch.

thermotropic model. A **model atmosphere** used in numerical forecasting in which the parameters to be forecast are the height of one constant-pressure surface (usually 500 millibars) and one temperature (usually the mean temperature between 1000 and 500 millibars). Thus, a surface prognostic chart can also be constructed. The quasi-geostrophic approximation is employed and the thermal wind is assumed constant with height. See **equivalent barotropic model.**

thindown. The expenditure of heavy **primary cosmic-ray** energy in **ionizing** the substance, normally air, through which it passes. See **bremsstrahlung.**

third law of thermodynamics. The statement that every substance has a finite positive **entropy,** and that the entropy of a crystalline substance is zero at the temperature of absolute zero. See **thermodynamic probability.**

Modern quantum theory has shown that the entropy of crystals at 0° absolute is not necessarily zero. If the crystal has any asymmetry, it may exist in more than one state; and there is, in addition, an entropy residue deriving from nuclear spin.

three-body problem. That problem in classical **celestial mechanics** which treats the motion of a small body, usually of negligible mass, relative to and under the gravitational influence of two other finite point masses.

threshold. Generally, the minimum value of a **signal** that can be detected by the **system** or **sensor** under consideration.

threshold contrast. The smallest contrast of **luminance** (or brightness) that is perceptible to the human eye under specified conditions of **adaptation luminance** and target visual angle. Also called *contrast threshold, liminal contrast.* Compare **threshold illuminance.**

Psychophysically, the existence of a threshold contrast is merely a special case of the general rule that for every sensory process there is a corresponding lowest detectable intensity of stimulus, i.e., a **limen.**

threshold illuminance. The lowest value of illuminance which the eye is capable of detecting under specified conditions of **background luminance** and degree of **dark adaptation** of the eye. Also called *flux-density threshold.* Compare **threshold contrast.** See **Allard law.**

This threshold, which controls the visibility of point light sources, especially at night, cannot be assigned any universal value, but nonflashing lights can generally be seen by a fully dark-adapted eye when the lights yield an illuminance of the order of 10^{-1} lumen per square kilometer at the eye.

threshold of audibility. For a specified **signal,** the minimum effective **sound pressure level** of the signal that is capable of evoking an auditory sensation in a specified fraction of the trials. The characteristics of the signal, the manner in which it is presented to the listener, and the point at which the sound pressure level is measured must be specified. Also called *threshold of detectability.*

Unless otherwise indicated, the ambient noise reaching the ears is assumed to be negligible.

The threshold is usually given as a sound pressure level in decibels, relative to 0.0002 microbar.

Instead of the method of constant stimuli, which is implied by the phrase *a specified fraction of the trials,* another psychophysical method (which should be specified) may be employed.

threshold of detectability = threshold of audibility.

threshold of discomfort. In acoustics, for a specified **signal,** the minimum effective **sound pressure level** of that signal which, in a specified fraction of the trials, will stimulate the ear to a point at which the sensation of feeling becomes uncomfortable. The term applies similarly for other senses.

threshold of feeling. In acoustics, for a specified **signal,** the minimum **sound pressure level** at the entrance to the external auditory canal which, in a specified fraction of the trials, will stimulate the ear to a point at which there is a sensation of feeling that is different from the sensation of hearing. Also called *tickle.*

threshold of pain. In acoustics, for a specified **signal,** the minimum effective **sound pressure level** of that signal which, in a specified fraction of the trials, will stimulate the ear to a point at which the discomfort gives way to definite pain that is distinct from mere non-noxious feeling

of discomfort. The term applies similarly for other senses.

threshold sensitivity. Of a **transducer,** the lowest level of the **input** signal which produces desired response at the **output.** The term applies equally to psychophysics.

throat. The narrowest portion of a constricted duct, as in a diffuser, a venturi tube, etc., specifically, a **nozzle throat.**

throatable. Of a nozzle: designed so as to allow a change in the velocity of the exhaust stream through changing the size and shape of the **throat** of the **nozzle.**

throat velocity = critical velocity.

throttling. The varying of the **thrust** of a **rocket engine** during powered flight by some technique.

Tightening of fuel lines, changing of thrust chamber pressure, pulsed thrust, and variation of nozzle expansion are methods to achieve throttling.

throughput. In vacuum technology, the quantity of **gas** in **pressure-volume units** at a specified temperature flowing per unit time across a specified open section of a pump or pipeline.

The specified temperature may be the actual temperature of the gas or a standard reference temperature. It is recommended that throughput be referred to standard room temperature. The recommended unit of throughput is the *torr liter per second at 20° C.* Other units of throughput in common use are *micron liters per second at 25° C* and *micron cubic feet per minute at 68° F.*

Under conditions of steady-state conservative flow the throughput across the entrance to a pipe is equal to the throughput at the exit. In this case throughput can be defined as the quantity of gas flowing through a pipe in pressure-volume units per unit time at room temperature.

thrust. **1.** The pushing or pulling force developed by an aircraft engine or a **rocket engine.** **2.** The force exerted in any direction by a fluid jet or by a powered screw, as, *the thrust of an antitorque rotor.* **3.** (*symbol* **F**). Specifically, in rocketry, $F = mv$ where m is propellant mass flow and v is exhaust velocity relative to the vehicle. Also called *momentum thrust.*

thrust augmentation. The increasing of the **thrust** of an engine or power plant, especially of a **jet engine** and usually for a short period of time, over the thrust normally developed.

The principal methods of thrust augmentation are the introduction of additional air into the induction system, liquid injection, and afterburning. With a piston engine, *thrust augmentation* usually refers to the direction of exhaust gases so as to give additional thrust.

thrust augmenter. Any device used to increase the thrust of a piston, jet, or rocket engine, such as an **afterburner.** See **augmenter tube.**

thrust axis. A line or **axis** through an aircraft, rocket, etc., along which the **thrust** acts; an axis through the longitudinal center of a jet or rocket engine along which the thrust of the engine acts; a center of thrust. Also called *axis of thrust.*

thrust chamber = firing chamber.

thrust coefficient = nozzle thrust coefficient.

thrust horsepower. **1.** The force-velocity equivalent of the **thrust** developed by a jet or rocket engine. **2.** The **thrust** of an engine-propeller combination expressed in horsepower. It differs from the shaft horsepower of the engine by the amount the propeller efficiency varies from 100 percent.

thrust loading. The weight-thrust ratio of a jet or rocket-propelled aircraft or other vehicle expressed as gross weight in pounds divided by **thrust** in pounds. See **power loading.**

thrust meter. An instrument for measuring static **thrust,** especially of a jet engine or rocket. See **reaction balance.**

thrust power. The power usefully expended on **thrust,** equal to the thrust (or **net thrust**) times airspeed.

thrust reverser. A device or apparatus for reversing **thrust,** especially of a **jet engine.** See **reverse thrust.**

thrust section. **1.** A section in a **rocket vehicle** that houses or incorporates the **combustion chamber** or chambers and **nozzles.** **2.** In loose usage, a propulsion system.

thrust terminator. A device for ending the **thrust** in a **rocket engine,** either through propellant **cutoff** (in the case of a liquid) or through diverting the flow of gases from the **nozzle.**

thrust-weight ratio. A quantity used to evaluate engine performance, obtained by dividing the **thrust** output by the engine weight less fuel. If the pound is used as the unit of measure for thrust and weight, the result is pounds of thrust per pound of engine.

tick. A short audible **sound** or beat, as that of a clock. A time signal in the form of one or more ticks is called a *time tick.*

tickle = threshold of feeling.

tidal day = lunar day.

tide. The periodic rising and falling of the earth's oceans and **atmosphere.** It results from the **gravitational** forces of the moon and sun acting upon the rotating earth. The disturbance actually propagates as a wave through the atmosphere and along the surface of the waters of the earth.

Atmospheric tides are always so designated, whereas the term *tide* alone commonly implies the oceanic variety.

tilt table. A device used to calibrate linear **accelerometers** with rated ranges of, or below, ± 1.0 g.

It allows the accelerometer to be positioned at different angles in reference to a surface perpendicular to the direction of the earth's gravity, so that the applied values of acceleration are equal to the cosine of the angle between the reference surface and the direction of the earth's gravity.

timbre. That attribute of auditory sensation by which a listener discriminates between two sounds of similar **loudness** and **pitch,** but of different tonal quality.

Timbre depends primarily upon the spectrum of the stimulus, but it also depends upon the waveform, the sound pressure, the frequency location of the spectrum, and the temporal characteristics of the stimulus.

time (*symbol* t or τ). The hour of the day reckoned by the position of a celestial reference point relative to a reference **celestial meridian.**

Time may be designated *solar*, *lunar*, or *sidereal* as the reference is the sun, moon, or vernal equinox, respectively. Solar time may be further classified as *mean* or *astronomical* if the mean sun is the reference, or as *apparent* if the apparent sun is the reference. Time may also be designated according to the reference meridian, either the *local* or *Greenwich* meridian or, additionally, in the case of mean solar time, a designated zone meridian. Standard and daylight-saving time are variations of zone time. Time may also be designated according to the timepiece, as *chronometer time* or *watch time*, the time indicated by these instruments.

time constant. Generally, the time required for an instrument to indicate a given percentage of the final reading resulting from an input signal; the **relaxation time** of an instrument. In the case of instruments such as thermometers, whose response to step changes in an applied signal is exponential in character, the time constant is equal to the time required for the instrument to indicate 63.2 percent of the total change, that is, when the transient error is reduced to $1/e$ of the original signal change. Also called *lag coefficient.* See **lag.** Compare **rise time, time lag.**

time division multiplex. A system for the transmission of information about two or more quantities (**measurands**) over a common **channel** by dividing available time intervals among the measurands to form a composite **pulse train.**

Information may be transmitted by variation of pulse duration, pulse amplitude, pulse position, or by a pulse code. (Abbreviations used are PDM, PAM, PPM, and PCM, respectively.)

time lag. The total time between the application of a **signal** to a measuring instrument and the full indication of that signal within the uncertainty of the instrument.

time of useful consciousness. The period between loss of oxygen supply (at altitude) and the inability of the individual to function efficiently.

time series. The values of a **variable** generated successively in time.

A continuous barograph trace is an example of a *continuous time series*, whereas a sequence of hourly pressures is an example of a *discrete time series*. Graphically, a time series is usually plotted with time as the abscissa and the values of the function as the ordinate.

time signal. 1. An accurate **signal** marking a specified time or time interval. It is used primarily for determining errors of timepieces. Such signals are usually sent from an observatory by radio or telegraph. **2.** In photography, a time indication registered on the film to serve as a time reference for interpretation of the date recorded on the film.

time tic. Markings on **telemetry** records to indicate time intervals.

time tick. A *time signal* consisting of one or more short audible sounds or beats.

time to unconsciousness. The period between loss of oxygen supply (at altitude) and the onset of unconsciousness.

time zone. See **zone time.**

timing parallax. The distance on a film between a frame and a **time signal** which were simultaneously exposed.

timing pulse. In telemetry, a **pulse** used as a time reference.

Titan. A **satellite** of Saturn orbiting at a mean distance of 1,222,000 kilometers.

Titania. A **satellite** of Uranus orbiting at a mean distance of 438,000 kilometers.

tolerance. The allowable variation in measurements within which the dimensions of an item are judged acceptable.

topocentric. Of measurements or **coordinates,** referred to the position of the observer on the earth as the origin.

topple. Of a gyro, the vertical component of **precession** or **wander,** or the algebraic sum of the two.

topple axis. That horizontal axis, perpendicular to the (horizontal) **spin axis** of a gyroscope, around which **topple** occurs.

tor = torr.

torching. The **degassing** of a vacuum system by application of a gas burner flame to the walls during the pumping process.

torque (*symbol* T). About an axis, the product of a **force** and the distance of its line of action from the **axis.**

torquer. In a gyro, a device which produces **torque** about an **axis of freedom** in response to a signal input.

torquing. In a gyro, the application of **torque** to a gimbal about an **axis of freedom** for the following purposes: **precessing, capturing, slaving, caging,** or **slewing.**

torr. Provisional international standard term to replace the English term *millimeter of mercury* and its abbreviation *mm of Hg* (or the French *mm de Hg*).

The torr is defined as 1/760 of a standard atmosphere or 1,013,250/760 dynes per square centimeter. This is equivalent to defining the torr as 1333.22 microbars and differs by only one part in 7 million from the International Standard millimeter of mercury. The prefixes *milli* and *micro* are attached without hyphenation.

total conductivity. In atmospheric electricity, the sum of the electrical conductivities of the positive and negative **ions** found in a given portion of the **atmosphere.**

total curvature. The change in direction of a **ray** between object and observer.

total eclipse. An **eclipse** in which the entire source of light is obscured.

total emissive power. See **emittance.**

total emissivity (*symbol* ϵ). See **emissivity.**

total emittance = **total emissive power.** See **emittance.**

total energy equation. In meteorology, an expression relating all forms of energy obtained by combining the **thermodynamic energy equation** with the **mechanical energy equation.** This equation expresses the fact that the combined internal, kinetic, and potential energy in a given volume of the atmosphere can vary only as a result of: (**a**) the transport of these forms of energy across the boundaries of the volume; (**b**) the work done by pressure forces on the boundary; (**c**) the addition or removal of heat; and (**d**) the dissipational effect of friction.

total head = **total pressure,** sense **3.**

total impulse (*symbol* I_t). The integral of the thrust F over an interval of time *t*:

$$I_t = \int F\,dt$$

Total impulse is related to **specific impulse** I_{sp} by $I_t = I_{sp}\dot{w}\,dt$, where $\dot{w}$ = propellant flow weight rate.

total potential energy. See **internal energy,** note.

total pressure. 1. = **stagnation pressure. 2.** = **impact pressure. 3.** The pressure a moving fluid would have if it were brought to rest without losses. **4.** The pressure determined by all the molecular species crossing the imaginary surface.

total-pressure tube. A tube for measuring the **stagnation pressure** of a **fluid;** i.e., **a pitot tube.**

total radiation. Radiation over the entire **spectrum** of emitted wavelengths.

total refraction. The return of **waves** out of a medium or layer, due to **refraction.**

Total refraction occurs most readily at low elevation angles. For any suitable layer in the atmosphere, there is a critical beam elevation angle below which total refraction can occur. In the ionosphere this angle is frequency dependent.

total scattering coefficient = **scattering coefficient.**

total scattering cross section = **scattering power;** see **scattering cross section.**

total solar eclipse. See **solar eclipse.**

toughness. The ability of a metal to absorb energy and deform plastically before fracturing.

Toughness is usually measured by the energy absorbed in a notch impact test, but the area under the stress-strain curve in tensile testing is also a measure of toughness.

towering. A **refraction** phenomenon; a special case of **looming** in which the downward curvature of the light rays due to **atmospheric refraction** increases with elevation so that the visual image of a distant object appears to be stretched in the vertical direction. The opposite of *towering* is *stooping.*

Townsend discharge. A type of **direct-current discharge** between two **electrodes** immersed in a gas and requiring electron emission from the cathode.

Townsend ionization coefficient. The average number of ionizing **collisions** an electron will make in drifting a unit distance in the direction of the applied electric force.

These coefficients were first measured by Townsend and at present they are well tabulated for most gases. A typical value for the coefficient is one pair per centimeter at a pressure of 1 millimeter of mercury and a field strength of 100 volts per centimeter.

TrA, Tr Au. International Astronomical Union abbreviations for *Triangulum Australe.* See **constellation.**

trace. The line appearing on the face of a **cathode-ray tube** when the visible dot repeatedly sweeps across the face of the tube as a result of deflections of the **electron beam.** See **sweep.**

The path of the dot from the end of one sweep to the start of the next sweep is called a *retrace.* If more than one trace is shown on the same scope, the traces may be called *A-trace, B-trace,* etc.

track. 1. The path or actual line of movement of an aircraft, rocket, etc., over the surface of the earth. It is the projection of the **flight-path** on the surface. **2.** To observe or plot the path of something moving, such as an aircraft or rocket, by one means or another, as by telescope or by radar—said of persons or of electronic equipment, as, *the observer, or the*

radar, tracked the satellite. **3.** To follow a desired track.

tracking. **1.** The process of following the movements of an object. This may be done by keeping the **reticle** of an optical system or a **radar beam** on the object, by plotting its **bearing** and distance at frequent intervals, or by a combination of the two. **2.** A motion given to the major **lobe** of an **antenna** so that a preassigned moving target in space remains in the lobe's field as long as it is within viewing range.

tracking antenna. A **directional antenna** system which changes in position, or characteristics, automatically or manually to follow the motions of a moving **signal** source.

tracking filter. An electronic device for attenuating unwanted signals while passing desired **signals,** by means of **phase-lock** techniques which reduce the effective **bandwidth** of the circuit and eliminate amplitude variations.

tracking offset error. The angular **error,** in magnitude and direction, between an object being tracked and the center of reference established for the **tracking** instrument.

tracking radar. A **radar** used for following a **target.**

tracking rate. The rate at which an operator or a system follows a **target.**

Usually expressed in terms of the rate of change of the parameter being measured.

tracking station. A station set up to **track** an object moving through the atmosphere or space, usually by means of **radar** or radio. See **minitrack.**

train. Anything, such as luminous gas or ionized particles, left along the **trajectory** of a **meteor** after the head of the meteor has passed.

trajectory. In general, the path traced by any body moving as a result of an externally applied force, considered in three dimensions.

Trajectory is sometimes used to mean *flight path* or *orbit*, but *orbit* usually means a closed path and *trajectory*, a path which is not closed.

trajectory-measuring system. A **system** used to provide information on the spatial position of an object at discrete time intervals throughout a portion of the **trajectory** or flightpath.

transceiver. A combination **transmitter** and **receiver** in a single housing, with some components being used by both units. See **transponder.**

transducer. A device capable of being actuated by **energy** from one or more **transmission** systems or media and of supplying related energy to one or more other transmission systems or media, as a microphone, a thermocouple, etc.

The energy in input and output may be of the same or different types (e.g, electric, mechanical, or acoustic).

transducer gain. The ratio of the **power** that a **transducer** delivers to a specified **load** under specified operating conditions to the available power of a specified source.

If the input and/or output power consist of more than one component, such as multifrequency signal or noise, then the particular components used and their weighting must be specified.

This gain is usually expressed in decibels.

transfer ellipse = transfer orbit.

transfer orbit. In interplanetary travel, an elliptical **trajectory** tangent to the **orbits** of both the departure planet and the target planet. Also called *transfer ellipse.*

transient problem = initial-value problem.

transistor. An active **semiconductor** device with three or more **electrodes.**

transit. **1.** The passage of a **celestial body** across a **celestial meridian,** usually called *meridian transit.* **2.** The apparent passage of a celestial body across the face of another celestial body or across any point, area, or line. **3.** An instrument used by an astronomer to determine the exact instant of meridian transit of a celestial body. **4.** A reversing instrument used by surveyors for accurately measuring horizontal and vertical angles; a theodolite which can be reversed in its supports without being lifted from them.

transition flow = Knudsen flow. See **rarefied gas dynamics,** note.

transition maneuver. In lifting flight, a maneuver required to fly smoothly from one **equilibrium glidepath** to another, performed by changing **attitude** in some manner.

transition point. In aerodynamics, the point of change from **laminar** to **turbulent flow.**

transition temperature. **1.** An arbitrarily defined temperature within the temperature range in which metal fracture characteristics determined usually by notched tests are changing rapidly such as from primarily fibrous (shear) to primarily crystalline (cleavage) fracture. **2.** The arbitrarily defined temperature in a range in which the ductility of a material changes rapidly with temperature.

translation. Movement in a straight line without **rotation.**

translational energy. In a gas, the **energy** associated with random straight line motion of the **molecules.**

translator. A **network** or system having a number of inputs and outputs and so connected that **signals** representing information expressed in a certain **code,** when applied to the inputs, cause output signals to appear which are a representation of the input information in a different code. Sometimes called *matrix.*

translunar. Outside the moon's orbit about the earth.

translunar space. As seen from the earth at any moment, **space** lying beyond the **orbit** of the moon.

transmission. **1.** The process by which **radiant flux** is propagated through a medium or body. **2.** = **transmittance.**

transmission coefficient (*symbol* τ). **1.** A measure of the amount of incident **radiation** which remains in a **beam** after it passes through a unit thickness of a medium. It is comparable in concept to the **extinction coefficient** (or **attenuation coefficient**) and is related to the extinction coefficient σ as follows:

$$\tau = e^{-\sigma}$$

where τ is the transmission coefficient. Its relationship to transmissivity r is expressed:

$$r = \tau^x$$

where x is the total thickness of the medium. Compare **absorption coefficient.** **2.** The fraction of the solar radiation normally incident upon the top of the atmosphere which survives passage through the atmosphere to the earth's surface. As so defined, a better term might be *atmospheric transmissivity.* **3.** The ratio of the **sound** transmitted through an interface or septum between two media, exposed to the sound field, to the sound energy incident on the interface or septum.

transmission loss. The reduction in the **magnitude** of some characteristic of a **signal** between two stated points in a **transmission system.** Also called *loss.*

The characteristic is often some kind of level, such as power level or voltage level; in acoustics, the characteristic that is commonly measured is sound pressure level. Thus, if the levels are expressed in decibels, the transmission level loss is likewise in decibels.

It is imperative that the characteristic concerned (such as the sound pressure level) be clearly identified because in all transmission systems more than one characteristic is propagated.

transmission system. A **system** which propagates or transmits **signals.**

transmission time. The time interval between dispatch and reception of a **signal** in a particular transmission system.

transmissivity = **transmittance.**

transmissometer. An instrument for measuring the **extinction coefficient** of the atmosphere and for the determination of **visual range.** Also called *telephotometer, transmittance meter, hazemeter.* See **photoelectric transmittance meter, visibility meter.**

transmissometry. The technique of determining the **extinction** characteristics of a medium by measuring the **transmittance** of a light beam of known initial intensity directed into that medium.

transmittance (*symbol* ***T***). The ratio of the **radiant flux** transmitted by a medium or a body to the incident flux. See **transmission coefficient.**

The transmittance T of radiant flux through a medium of thickness x is related to the transmission coefficient τ of that medium by $T = \tau$.

transmittance meter = **transmissometer.**

transmitted power. The **power** which is radiated from an **antenna.** Compare **received power.**

transmitter. A device used for the generation of **signals** of any type and form which are to be transmitted. See **receiver.**

In radio and radar, it is that portion of the equipment which includes electronic circuits designed to generate, amplify, and shape the radiofrequency energy which is delivered to the antenna where it is radiated out into space.

transonic. Pertaining to that which occurs or is occurring within the range of speed in which flow patterns change from subsonic to supersonic or vice versa, about Mach 0.8 to 1.2, as in *transonic flight, transonic flutter;* that operates within this regime, as in *transonic aircraft, transonic wing;* characterized by transonic flow or transonic speed, as in *transonic region, transonic zone.*

transonic flow. In aerodynamics, flow of a fluid over a body in the range just above and just below the **acoustic velocity.**

Transonic flow presents a special problem in aerodynamics in that neither the equations describing subsonic flow nor the equations describing supersonic flow can be applied in the transonic range.

transonic speed. The speed of a body relative to the surrounding **fluid** at which the **flow** is in some places on the body **subsonic** and in other places **supersonic.**

transparent plasma. A **plasma** through which an **electromagnetic wave** can **propagate.** In general, a plasma is transparent for frequencies higher than the **plasma frequency.**

transpiration. The passage of gas or liquid through a porous solid (usually under conditions of **molecular flow**).

transpiration cooling. A process by which a body having a porous surface is cooled by forced flow of **coolant** fluid through the surface from the interior. Compare **film cooling.**

transponder. A combined **receiver** and **transmitter** whose function is to transmit signals automatically when triggered by an **interrogator.** See **transceiver.**

transponder beacon. A **beacon** having a **transponder.** Also called *responder beacon.*

transport = **flux.**

transverse. In cartography, pertaining to or measured on a map projection in which a **meridian** is used as a fictitious **equator.**

transverse sensivity = **cross sensitivity.**

transverse vibration. **Vibration** in which the direction of motion of the particles is perpendicular to the direction of advance of the vibratory motion, in contrast with longitudinal vibration, in which the direction of motion is the same as that of advance.

transverse wave. A wave in which the direction of **displacement** at each point of the medium is parallel to the **wave front.** Contrast **longitudinal wave.**

trap. A part of a **solid-propellant rocket engine** used to prevent the loss of unburned **propellant** through the **nozzle.**

trapping. The process by which radiation **particles** are caught and held in a **radiation belt.**

Tr Au. International Astronomical Union abbreviation for Triangulum Australe. See **constellation.**

traveling plane wave. A **plane wave** each of whose frequency components has an exponential variation of **amplitude** and a linear variation of **phase** in the direction of **propagation.**

traveling-wave tube (*abbr* **TWT**). An **electron tube** in which a stream of electrons interacts continuously or repeatedly with a guided **electromagnetic wave** moving substantially in synchronism with it, and in such a way that there is a net transfer of energy from the stream to the wave.

Tri, Tria. International Astronomical Union abbreviations for Triangulum. See **constellation.**

Triangulum (*abbr* **Tri, Tria**). See **constellation.**

Triangulum Australe (*abbr* **TrA, Tr Au**). See **constellation.**

Tridop. A continuous-wave **trajectory-measuring system** using the **Doppler shift** caused by a target moving relative to a ground transmitter and three or more receiving stations.

triple point. The thermodynamic state at which three phases of a substance exist in equilibrium.

The triple point of water occurs at a saturation vapor pressure of 6.11 millibar and at a temperature of 273.16° K.

triplexer. A dual-**duplexer** which permits the use of two receivers simultaneously and independently in a **radar** system by disconnecting the receivers during the transmitted **pulse.**

Triton. A **satellite** of Neptune orbiting at a mean distance of 354,000 kilometers.

trochoid. The path followed by a point in a diameter of a circle as the circle rolls along a straight line.

trochotron. An **electron tube** in which a **magnetic field** causes the electrons to travel in trochoidal paths. See **beam-switching tube.**

Trojan asteroids. Two groups of minor planets that librate in long-period **orbits** around the stable **Lagrangian points** of the Sun and Jupiter.

Called *Trojan* because they are named after heroes of the Trojan War.

tropical. Of or pertaining to the **vernal equinox.** See **sidereal.**

tropical month. The average period of the **revolution** of the moon about the earth with respect to the **vernal equinox,** a period of 27 days 7 hours 43 minutes 4.7 seconds, or approximately $27\frac{1}{3}$ days.

tropical year. The period of one **revolution** of the earth around the sun, with respect to the **vernal equinox.**

Because of precession of the equinoxes, the tropical year is not 360° with respect to the stars, but 50 minutes 0.3 second less. A tropical year is about 20 minutes shorter than a sidereal year, averaging 365 days 5 hours 48 minutes 45.68 seconds in 1955 and is increasing at the rate of 0.005305 second anually. Also called *astronomical, equinoctial, natural,* or *solar year.*

tropic of Cancer. The northern **parallel of declination,** approximately 23°27′ from the celestial equator, reached by the sun at its maximum declination, or the corresponding parallel on the earth.

It is named for the sign of the zodiac in which the sun reached its maximum northerly declination at the time the parallel was so named.

tropic of Capricorn. The southern **parallel of declination,** approximately 23°27′ from the celestial equator, reached by the sun at its

maximum declination, or the corresponding parallel on the earth.

It is named for the sign of the zodiac in which the sun reached its maximum southerly declination at the time the parallel was so named.

tropopause. The boundary between the **troposphere** and **stratosphere,** usually characterized by an abrupt change of **lapse rate.** The change is in the direction of increased atmospheric stability from regions below to regions above the tropopause. Its height varies from 15 to 20 kilometers in the tropics to about 10 kilometers in polar regions. In polar regions in winter it is often difficult or impossible to determine just where the tropopause lies, since under some conditions there is no abrupt change in lapse rate at any height.

troposphere. That portion of the **atmosphere** from the earth's surface to the **stratosphere;** that is, the lowest 10 to 20 kilometers of the atmosphere. The troposphere is characterized by decreasing temperature with height, appreciable vertical wind motion, appreciable water-vapor content, and weather. Dynamically, the troposphere can be divided into the following layers: **surface boundary layer, Ekman layer,** and **free atmosphere.** See **atmospheric shell.**

tropospheric wave. A **radio wave** that is **propagated** by reflection from a place of abrupt change in the **dielectric constant** or its gradient in the **troposphere.**

In some cases the ground wave may be so altered that new components appear to arise from reflections in regions of rapidly changing dielectric constants; when these components are distinguishable from the other components, they are called tropospheric waves.

trud count. (From *t*ime *r*emaining *u*ntil *d*ive.) A count (in minutes and seconds) that measures the time between a rocket **launch** and the moment it apogees and begins its dive.

true. 1. Related to or measured from true north. **2.** Actual, as contrasted with fictitious, as *true sun.* **3.** Related to a fixed point, either on the earth or in space, as *true wind;* in contrast with *relative.* **4.** Corrected, as *true altitude.*

true altitude. 1. Actual height above sea level; calibrated altitude corrected for air temperature. **2.** The actual **altitude** of a celestial body above the celestial horizon. Usually called *observed altitude.*

true anomaly. See **anomaly.**

true meridian. A **great circle** through the geographical poles, distinguished from **magnetic meridian, grid meridian,** etc.

true position. The position of a **celestial body** (or space vehicle) on the **celestial sphere** as computed directly from the elements of the **orbit** of the earth and the body concerned without allowance for **light time.** Also called *geometric position.*

true prime vertical. The **vertical circle** through the true east and west points of the **horizon,** as distinguished from magnetic, compass, or grid prime vertical through the magnetic, compass, or grid east and west points, respectively.

true sun. The actual sun as it appears in the sky. Usually called *apparent sun.* See **mean sun, dynamical mean sun.**

truncation error. In computations, the **error** resulting from the use of only a finite number of terms of an infinite series or from the approximation of operations in the infinitesimal calculus by operations in the calculus of finite differences.

trunk = bus.

T-time. Any specific time, minus or plus as referenced to zero or launch time, during a **countdown** sequence that is intended to result in the firing of a rocket propulsion unit that launches a rocket vehicle.

Tucana (*abbr* **Tuc, Tucn**). See **constellation.**

Tucn. International Astronomical Union abbreviation for *Tucana.* See **constellation.**

Tuc, Tucn. International Astronomical Union abbreviations for *Tucana.* See **constellation.**

tumble. 1. To rotate end over end—said of a rocket, of an ejection capsule, etc. **2.** Of a gyro, to **precess** suddenly and to an extreme extent as a result of exceeding its operating limits of bank or pitch.

tumbling. An attitude situation in which the vehicle continues on its flight, but turns end over end about its center of mass.

tuned damper. A device for reducing **vibration** of a primary system by the transfer of energy to an auxiliary **resonant system** which is tuned to the frequency of the vibration. The force exerted by the auxiliary system is opposite in **phase** to the force acting on the primary system.

tunnel. 1. A structure, installation, or facility incorporating apparatus to simulate flight conditions in one way or another, specially designed for testing or experimenting with power plants, or with aircraft, rockets, or other aerodynamically designed bodies, engine installations, or models; specifically, a **wind tunnel. 2.** A longitudinal protuberance on a rocket

body used to house wiring, piping, etc., so as to not route the wiring through the propellant tanks.

tunnel axis. Any one of the geometrical **axes** of a **wind tunnel.**

turbidity. In meteorology, any condition of the **atmosphere** which reduces its transparency to **radiation,** especially to visible radiation.

Ordinarily, this is applied to a cloud-free portion of the atmosphere that owes its turbidity to air molecules and suspensoids such as smoke, dust, and haze, and to scintillation effects.

turbidity factor. A measure of the atmospheric transmission of incident **solar radiation.**

If I_o is the flux density of the solar beam just outside the earth's atmosphere, I the flux density measured at the earth's surface with the sun at a zenith distance which implies an optical air mass m, and $I_{m,w}$ the intensity which would be observed at the earth's surface for a pure atmosphere containing one centimeter of precipitable water viewed through the given optical air mass, then Linke's turbidity factor θ is given by

$$\theta = (\ln I_o - \ln I)/(\ln I_o - \ln I_{m,w})$$

turbine. **1.** A machine consisting principally of one or more **turbine wheels** and a **stator.** **2.** A turbine wheel. **3.** A **turbine engine.** See **blowdown turbine, explosion turbine, free turbine, gas turbine, impulse turbine, partial-admission turbine, reaction turbine, single-stage turbine.**

turbine blade. Any one of the **blades** of a **turbine wheel.**

turbine engine. An engine incorporating a **turbine** as a principal component; especially, a **gas-turbine engine.**

turbine wheel. A multivaned wheel or **rotor,** especially in a **gas-turbine engine,** rotated by the impulse from or reaction to a **fluid** passing across the vanes. Often called a *turbine.*

turbofan. A **turbojet engine** in which additional propulsive thrust is gained by extending a portion of the **compressor** or **turbine** blades outside the inner engine case.

The extended blades propel bypass air which flows along the engine axis but between the inner and outer engine casing. This air is not combusted but does provide additional thrust caused by the propulsive effect imparted to it by the extended compressor blading.

turbojet. **1.** = **turbojet engine.** **2.** A craft propelled by a turbojet engine. See **jet engine.**

turbojet engine. A **jet engine** incorporating a turbine-driven air **compressor** to take in and compress the air for the combustion of fuel (or for heating by a nuclear reactor), the gases of combustion (or the heated air) being used both to rotate the **turbine** and to create a thrust-producing jet. Often called a *turbojet.* See **jet engine,** sense **2.**

turbulence. **1.** A state of fluid **flow** in which the instantaneous velocities exhibit irregular and apparently random fluctuations so that in practice only statistical properties can be recognized and subjected to analysis. Compare **laminar flow.**

These fluctuations often constitute major deformations of the flow and are capable of transporting momentum, energy, and suspended matter at rates far in excess of the rate of transport by the molecular processes of diffusion and conduction in a nonturbulent or laminar flow.

turbulent boundary layer. The layer in which the **Reynolds stresses** are much larger than the **viscous stresses.** When the **Reynolds number** is sufficiently high, there is a turbulent layer adjacent to the **laminar boundary layer.**

turbulent flow. Fluid motion in which random motions of parts of the **fluid** are superimposed upon a simple pattern of **flow.** All or nearly all fluid flow displays some degree of turbulence. The opposite is **laminar flow.**

turbulent scatter. See **scatter.**

turbulent shear stresses. See **Reynolds stresses.**

turn error. Any error in **gyro** output due to **cross-coupling** and **acceleration** encountered during vehicle turns.

turnover frequency = **Nyquist frequency.**

turnstile antenna. An **antenna** composed of two **dipole antennas,** normal to each other, with their axes intersecting at their midpoints. Usually, the currents are equal and in phase quadrature.

T-wave. In an electrocardiogram, the deflection which represents repolarization on the ventricles. It is normally upright, varying rather widely in amplitude and duration.

twenty-four hour satellite. A **synchronous satellite** of the earth.

twilight. The periods of incomplete darkness following sunset (evening twilight) or preceding sunrise (morning twilight).

Twilight is designated as *civil, nautical,* or *astronomical,* as the darker limit occurs when the center of the sun is at zenith distances of 96°, 102°, and 108°, respectively.

two-body problem. That problem in classical **celestial mechanics** which treats of the relative motion of two point masses under their mutual **gravitational** attraction.

two-color pyrometer. A **high-temperature thermometer** wherein spectral radiation from the object is measured at two different **wavelengths.**

Temperature may be deduced without knowledge of the **emittance** if (and only if) the object is a gray body. The method is applicable to gases and to opaque objects.

U

Udop (*abbr*) = **UHF Dovap.**

U-figure = **U-index.**

UHF Dovap (*abbr* **Udop**). A **Dovap** type **trajectory measuring system** operating in the UHF band. See **Doppler, velocity, and position.**

U-index. The difference between consecutive daily mean values of the horizontal component of the **geomagnetic field.** Also called *U-figure.* See **u-index.**

Each value is derived from a 48-hour interval covering 2 Greenwich-mean-time days, and is assigned to the second day of the pair. The monthly U-index, the mean of the daily values, is the most frequently used.

u-index. The value

$$u = U/\sin A \cos B$$

where U is the **U-index;** A is the magnetic **colatitude;** and B is the angle between the **magnetic meridian** and the horizontal component of the **magnetic field intensity.**

The annual and longer period mean values of the u-index exhibit one of the strongest solar and terrestrial activity relationships known.

ullage. The amount that a container, such as a fuel tank, lacks of being full.

ullage rocket. A small **rocket** used in space to impart an **acceleration** to a tank system to insure that the liquid propellants collect in the tank in such a manner as to flow properly into the pumps or thrust chamber.

ultimate pressure. The limiting **pressure** approached in a **vacuum system** after sufficient pumping time to establish that further reductions in pressure will be negligible. Also called the *ultimate vacuum.*

The terms *blank-off pressure* or *base pressure* are also sometimes used in referring to a pump under test.

ultimate strength. The maximum conventional **stress** (tensile, compressive, or shear) that a material can withstand.

ultimate vacuum = **ultimate pressure.**

ultrahigh frequency (*abbr* **UHF**). See **frequency bands.**

ultrahigh-speed motion-picture photography. Picture taking at a frequency range above 10,000 pictures per second.

ultrahigh vacuum. See **vacuum.**

ultrasonic. In acoustics, of or pertaining to **frequencies** above those that affect the human ear, i.e., more than 20,000 vibrations per second.

The term *ultrasonic* may be used as a modifier to indicate a device or system intended to operate at an ultrasonic frequency, as an *ultrasonic vibrator.*

Supersonic was formerly used in acoustics synonymously with *ultrasonic;* this usage is now rare.

ultrasonic frequency. A frequency lying above the **audiofrequency** range. The term is commonly applied to elastic waves propagated in gases, liquids, or solids. See **sound.**

ultrasonics. The technology of **sound** at frequencies above the audio frequency range.

Supersonics was once used in acoustics synonymously with *ultrasonics.* This usage is now rare.

ultrasonic wave. See **sound wave.**

ultraviolet (*abbr* **UV**). Pertaining to or same as **ultraviolet radiation.**

ultraviolet radiation. Electromagnetic radiation of shorter wavelength than **visible radiation;** roughly, radiation in the wavelength interval from 100 to 4000 angstroms. Also called *ultraviolet.* See **X-ray,** note.

Ultraviolet radiation from the sun is responsible for many complex photochemical reactions characteristic of the upper atmosphere; e.g., the formation of the ozone layer through ultraviolet dissociation of oxygen molecules followed by recombination to form ozone.

UMa, U Maj. International Astronomical Union abbreviations for *Ursa Major.* See **constellation.**

umbilical. Short for **umbilical cord.** Often used in the plural, *umbilicals.*

umbilical cord. Any of the servicing electrical or fluid lines between the ground or a tower and an uprighted **rocket vehicle** before the **launch.** Often shortened to *umbilical.*

umbilical tower. A vertical structure supporting the **umbilical cords** running into a **rocket** in launching position.

umbra. 1. The darkest part of a shadow in which light is completely cut off by an intervening object. A lighter part surrounding the umbra, in which the light is only partly cut off, is called the *penumbra.* **2.** The darker central portion of a **sun spot,** surrounded by the lighter penumbra.

Umbriel. A **satellite** of Uranus orbiting at a mean distance of 267,000 kilometers.

UMi, U Min. International Astronomical Union

abbreviations for *Ursa Minor.* See **constellation.**

Umkehr effect. Due to the presence of the **ozone layer,** an anomaly of the relative zenith intensities of scattered sunlight at certain wavelengths in the **ultraviolet** as the sun approaches the horizon.

uncoupled mode. A **mode** of **vibration** that can exist in a system concurrently with and independently of other modes.

undamped natural frequency. Of a mechanical system, the frequency of free vibration resulting from only elastic and **inertial forces** of the system.

underbreathing = hypoventilation.

underdeck spray. That part of a **pad deluge** in which the water is directed upward from under the **rocket.**

unidirectional antenna. An **antenna** which has a single well-defined direction of maximum **gain.**

union. In **Boolean algebra,** the operation in which concepts are described by stating that they have the characteristics of one or more of the classes involved. *Union* is expressed as **OR.**

unilateral transducer. A **transducer** that cannot be actuated at its **outputs** by waves in such a manner as to supply related waves at its **inputs.**

unipole. A hypothetical **antenna** radiating or receiving equally in all directions. Also called *isotropic antenna.*

A pulsating sphere is a unipole for sound waves. In the case of electromagnetic waves unipoles do not exist physically but represent convenient reference antennas for expressing directive properties of actual antennas.

universe. In statistical terminology, = **population.**

UV (*abbr*) = ***ultraviolet* radiation.**

universal gas constant. See **gas constant.**

universal gravitational constant. See **gravitation.**

universal time (*abbr* **UT**). **Time** defined by the rotational motion of the earth and determined from the apparent diurnal motions which reflect this **rotation;** because of variations in the rate of rotation, universal time is not rigorously uniform. Also called *Greenwich mean time.* Compare **ephemeris time.**

In the years preceding 1960 the arguments of the ephemerides in the American Ephemeris and Nautical Almanac were designated as *universal time.*

universal transmission function. A mathematical relationship that attempts to describe quantitatively the complex infrared propagation (including absorption and reradiation) in the atmosphere.

upper air. In **synoptic meteorology** and in weather observing, that portion of the **atmosphere** which is above the lower troposphere. Compare **upper atmosphere.**

No distinct lower limit is set but the term is generally applied to the levels above 850 millibars.

upper air observation. A measurement of atmospheric conditions aloft, above the effective range of a surface weather observation. Also called *sounding, upper air sounding.* See **radiosonde.**

This is a general term, but is usually applied to those observations which are used in the analysis of upper air charts (as opposed to measurements of upper atmospheric quantities primarily for research).

upper air sounding = upper air observation.

upper atmosphere. The general term applied to the **atmosphere** above the **troposphere.** Compare **upper air.**

For subdivisions of the upper atmosphere, see **atmospheric shell.**

upper branch. That half of a **meridian** or **celestial meridian** from pole to pole which passes through a place or its **zenith.**

upper culmination = upper transit.

upper limb. That half of the outer edge of a **celestial body,** especially the moon, having the greatest **altitude** in contrast with the lower limb, that half having the least altitude.

upper stage. A second or later **stage** in a **multistage rocket.**

upper transit. Transit of the **upper branch** of the **celestial meridian.** Also called *superior transit, upper culmination.* Transit of the lower branch is called *lower transit.*

Uranus. See **planet,** table.

Ursa Major (*abbr* **UMa, U Maj**). See **constellation.**

Ursa Minor (*abbr* **UMi, U Min**). See **constellation.**

URSI (*abbr*). International Scientific Radio Union. Usually pronounced as a word.

USNC-IGY (*abbr*). *U.S. N*ational *C*ommittee for the *I*nternational *G*eophysical *Y*ear, National Academy of Sciences.

UT (*abbr*) = ***universal* time.**

V

vacua. Sometimes used as the plural of **vacuum.**

vacuum. 1. A given space filled with **gas** at pressures below **atmospheric pressure.** Various approximate ranges are:

low vacuum, torr	760 to 25
medium vacuum, torr	25 to 10^{-3}
high vacuum, torr	10^{-3} to 10^{-6}
very high vacuum, torr	10^{-6} to 10^{-9}
ultrahigh vacuum, torr	10^{-9} and below

2. In reference to **satellite** orbital parameters, without consideration of the perturbing effects of an atmosphere, as in *vacuum perigee*, *vacuum apogee.*

vacuum gage. An instrument for measuring pressure below **atmospheric pressure.** Some of the more common types of vacuum gages listed in order of descending pressure range of use are: **(a) Manometer,** usually consists of a column of liquid supported by the pressure to be measured, the determination of which is a matter of measuring the column height. **(b) Thermal conductivity gage,** consisting of a heated surface. The heat transported by the gas molecules from the surface is related to gas pressure. The heat transfer is reflected in changes in surface temperature (or in the heating power required to maintain constant temperature).

Various types of thermal conductivity gages are distinguished according to the method of indicating the surface temperature. The most common types are **Pirani gage** and **thermocouple gage.**

(c) Knudsen gage, which measures pressure in terms of the net rate of transfer of momentum by molecules between two surfaces maintained at different temperatures and separated by a distance smaller than the mean free path of the gas molecule. Also called *radiometer vacuum gage.* **(d) McLeod gage,** in which a known volume of the gas, at the pressure to be measured, is compressed by the movement of a liquid column to a much smaller known volume, at which the resulting higher pressure is measured. **(e) Ionization gage,** comprising a means of ionizing the gas molecules and a means of correlating the number and type of ions produced with the pressure of the gas.

Various types of ionization gages are distinguished according to the method of producing the ionization. The common types are **hot-cathode ionization gage, cold-cathode ionization gage, radioactive ionization gage.**

vacuum pump. A device which sets up a flow of gas in a **vacuum system.** Some of the more common types are mechanical pump, vapor or diffusion pump, cryopump.

vacuum system. A chamber, or chambers, having walls capable of withstanding atmospheric pressure and having an opening through which the gas can be removed through a pipe or manifold to a pumping system. The pumping system may or may not be considered as part of the vacuum system.

A complete vacuum system contains all necessary pumps, gages, valves, work-holding fixtures, and other components necessary to carry out some particular process; such a system is referred to in England as a *vacuum plant.*

vacuum tube. An **electron tube** evacuated to such a degree that its electrical characteristics are essentially unaffected by the presence of residual gas or vapor.

valsalva maneuver. The procedure of raising the pressure in the **nasopharynx** by forcible expiration with the mouth closed and nostrils pinched, in order to clear the **eustachian tubes.**

Van Allen belt, Van Allen radiation belt. (For James A. Van Allen, 1915– .) The zone of high-intensity **particulate radiation** surrounding the earth beginning at altitudes of approximately 1000 kilometers.

The radiation of the Van Allen belt is composed of protons and electrons temporarily trapped in the earth's magnetic field. The intensity of radiation varies with the distance from the earth.

Van Allen radiation belt = Van Allen belt.

Van de Graaff generator. An electrostatic generator which employs a system of conveyor belt and spray points to charge an insulated **electrode** to a high potential.

Van der Waal equation. The best known of the many laws which have been proposed to describe the **thermodynamic** behavior of real gases and their departures from the **ideal gas laws.** It states:

$$[p + (a/v^2)]\ (v - b) = RT$$

where a and b are constants dependent upon the gas; p is the pressure of the gas; v is its

specific volume (measured in units of the specific volume of the gas at normal temperature and pressure); R is the universal gas constant; and T is the Kelvin temperature.

vane. **1.** A thin and more-or-less flat object intended to aline itself with a stream or **flow** in a manner similar to that of the common weathercock, as: (a) a device that projects ahead of an aircraft to sense gusts or other actions of the air so as to create impulses or signals that are transmitted to the control system to stabilize the aircraft; (b) a fixed or movable surface used to control or give stability to a rocket. See **control vane.** **2.** A blade or paddle-like object, often fashioned like an **airfoil** and usually one of several, that rotates about an axis, either being moved by a flow or creating a flow itself, such as the blade of a **turbine,** of a fan, of a rotary pump or air compressor, etc. See **impeller vane.** **3.** Any of certain stationary blades, plates, or the like that serve to guide or direct a flow, or to create a special kind of flow, as: (a) any of the blades in the **nozzle ring** of a gas-turbine engine; (b) any of the plates or slatlike objects that guide the flow in a wind tunnel; (c) a plate or fence projecting from a wing to prevent spanwise flow. See **contravane.** See **airfoil,** note.

vapor. A gas whose temperature is below its **critical temperature,** so that it can be condensed to the liquid or solid state by increase of pressure alone.

vapor pressure. **1.** The **pressure** exerted by the molecules of a given **vapor.** For a pure confined vapor, it is that vapor's pressure on the walls of its containing vessel; and for a vapor mixed with other vapors or gases, it is that vapor's contribution to the total pressure (i.e., its **partial pressure**). Also called *vapor tension.*

In meteorology, *vapor pressure* is used almost exclusively to denote the partial pressure of water vapor in the atmosphere. See **saturation vapor pressure, equilibrium vapor pressure.**

2. The sum of the partial pressures of all the vapors in a system.

vapor tension. **1.** The maximum possible vapor pressure that can be exerted, at a given temperature, by a system composed of a plane surface of a liquid or solid substance in contact with that substance's **vapor.** Compare **equilibrium vapor pressure, saturation vapor pressure.** **2.** = **vapor pressure** (obsolescent).

vapor thorax. A condition characterized by the existence of large **water-vapor** bubbles in the intrapleural space between the lungs and the chest wall, occurring when an unprotected person (or animal) is exposed to ambient pressures less than 47 millimeters of mercury and water at body temperature vaporizes from the liquid state.

vapor trail = **condensation trail.**

variable-area exhaust nozzle. On a **jet engine,** an exhaust **nozzle** of which the exhaust exit opening can be varied in area by means of some mechanical device, permitting variation in the jet velocity. Compare **fixed-area exhaust nozzle.**

variable cycle. Pertaining to a **computer** in which succeeding sequences are started by the completion of the previous sequence rather than at predetermined intervals. See **asynchronous computer.**

variance (*symbol* σ^2). In statistics, a measure of variability (or spread); the mean-square deviation from the **mean,** that is, the mean of the squares of the differences between individual values of x and the mean value μ.

$$\sigma^2 \equiv E[(x - \mu)^2] \equiv E(x^2) - \mu^2$$

where E denotes expected value. The positive square root σ of the variance is called the *standard deviation.*

variate = **random variable.**

variation. The angle between the **magnetic** and **geographical meridians** at any place, expressed in degrees east or west to indicate the direction of magnetic north from true north. Called *magnetic variation* when a specificity is needed to prevent possible ambiguity. Also called *magnetic declination.*

The angle between the magnetic and **grid meridians** is called *grid variation* or *grivation.*

variation of latitude. A small periodic change in the **astronomical latitude** of points on the earth, due to wandering of the poles.

variometer. An instrument for comparing magnetic **forces,** especially of the earth's **magnetic field.**

varistor. A two-electrode **semiconductor device** having a voltage-dependent nonlinear resistance.

V-band. A **frequency band** used in **radar** extending approximately from 46 to 56 gigacycles per second. See **frequency bands.**

vector. Any quantity, such as force, velocity, or acceleration, which has both magnitude and direction at each point in space, as opposed to a **scalar** which has magnitude only. Such a quantity may be represented geometrically by

an arrow of length proportional to its magnitude, pointing in the assigned direction.

A unit vector is a vector of unit length; in particular, the three unit vectors along the positive X-, Y-, and Z-axes of rectangular **Cartesian coordinates** are denoted, respectively, by **i**, **j**, and **k**. Any vector A can be represented in terms of its components a_1, a_2, and a_3 along the coordinate axes X, Y, and Z, respectively; e.g., $A = a_1i + a_2j + a_3k$. A vector drawn from a fixed origin to a given point (X, Y, Z) is called a *position vector* and is usually symbolized by r; in rectangular Cartesian coordinates,

$$r = xi + yj + zk$$

Equations written in vector form are valid in any coordinate system. Mathematically, a vector is a single-row or -column **array** of functions obeying certain laws of transformation. See **scalar product, vector product, tensor, Helmholtz theorem.**

vector product. A **vector** whose **magnitude** is equal to the product of the magnitudes of any two given vectors and the sine of the angle between their positive directions. Also called *cross product, outer product.* See **scalar product.**

For two vectors A and B, the vector product is often written $A \times B$ (read *A cross B*), and defines a vector perpendicular to both A and B and so directed that a right-hand rotation about $A \times B$ through an angle of not more than 180° carries A into B. The magnitude of $A \times B$ is equal to twice the area of the triangle of which A and B are coterminous sides. If the vector product is zero, one of the vectors is zero or else the two are parallel. When A and B are written in terms of their components along the X-, Y-, and Z-axes of the rectangular Cartesian coordinates, i.e.,

$$A = a_1i + a_2j + a_3k$$
$$B = b_1i + b_2j + b_3k$$

then the vector product is the determinant

$$A \times B = -B \times A = \begin{vmatrix} i & j & k \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

vector quantity = vector.

vector steering. A steering method for **rockets** and **spacecraft** wherein one or more **thrust chambers** are gimbal mounted so that the direction of the thrust force (thrust vector) may be tilted in relation to the center of gravity of the vehicle to produce a turning movement.

vehicle. Specifically, a structure, machine, or device, such as an aircraft or **rocket,** designed to carry a burden through air or space; more restrictively, a **rocket vehicle.**

This word has acquired its specific meaning owing to the need for a term to embrace aircraft, rockets, and all other flying craft, and has more currency than other words used in this meaning. See **launch vehicle.**

vehicle control system. A system, incorporating control surfaces or other devices, which adjusts and maintains the altitude and heading, and sometimes speed, of a **vehicle** in accordance with signals received from a guidance system.

The essential difference between a control system and a **guidance** system is that the control system points the vehicle and the guidance system gives the commands which tell the control system where to point. However, the control system maintains the instantaneous orientation of the vehicle without specific commands from the guidance system.

vehicle mass ratio. The ratio of the final mass of a vehicle m_f, after all propellant has been used, to the initial mass m_o:

$$\text{vehicle mass ratio} = m_f/m_o$$

The inverse ratio m_o/m_f is sometimes called **mass ratio** also.

Vel, Velr. International Astronomical Union abbreviations for *Vela.* See **constellation.**

Vela (*abbr* **Vel, Velr**). See **constellation.**

velocimeter. A continuous-wave reflection **Doppler** system used to measure the radial velocity of an object.

velocity (*symbol V*). **1. = speed.** See note. **2.** A **vector** quantity equal to speed in a given direction.

In sense **1**, *velocity* is often used synonymously with *speed*, as in *the velocity of the airplane*, but in such contexts *speed* is properly the preferred term; except in the compound *airspeed*, *velocity* is preferred to *speed* in reference to motion of air or other fluid.

velocity head. 1. = velocity pressure. 2. The unit energy of a **fluid** stream owing to its motion.

velocity microphone. A **microphone** in which the electric output substantially corresponds to the instantaneous particle velocity in the impressed **sound wave.**

velocity of escape. The initial speed an object, particularly a molecule of **gas,** must have at the surface of a **celestial body** to overcome the **gravitational** pull and proceed out into space without returning to the celestial body. Also called *escape velocity, escape speed.*

The velocity of escape determines a body's ability to retain an atmosphere. The velocity of escape on the surface of the earth is nearly 7 miles per second, neglecting air resistance.

velocity of light (*symbol* **c**) **= speed of light.**

velocity of propagation. Rate of flow of **electromagnetic radiation,** including: **(a)** Phase velocity. The velocity of propagation of surfaces of constant phase.

Strictly, this definition is applicable only to space periodic fields of infinite length.

(b) Group velocity. The velocity of propagation of electromagnetic radiant energy in a nondispersive or normally dispersive medium.

For a complex waveform, *group velocity* refers to the velocity of propagation of the *beats* between the component frequencies of the waveform.

(c) Signal velocity. The velocity of propagation of a signal.

In a nondispersive or normally dispersive medium, *signal* and *group velocity* are the same.

For pure CW (continuous-wave) systems, utilizing no modulation, phase velocity is applicable. For systems utilizing modulated CW, signal velocity is applicable.

velocity of sound = **speed of sound.**

velocity pressure. The difference between **dynamic** (or total) **pressure** and **static pressure.** Also called *velocity head.*

velocity space. The subspace of **phase space** whose coordinates are the velocities in each of the three directions of ordinary space.

velocity transducer. A **transducer** which generates an output proportional to imparted velocities.

Velr. International Astronomical Union abbreviation for *Vela.* See **constellation.**

ventilation. Biologically, the aeration of the lungs and blood by breathing; the inhalation and exhalation of air in the process of respiration.

ventilation garment. A lightweight, specially designed garment that is integrated with the **pressure suit** for providing adequate evaporation and heat dissipation from the surface of the body, by circulating dry air through the porous material.

ventral. Pertaining to the belly, or the underside of a vehicle, as *ventral camera.*

Venturi tube. A short tube of smaller diameter in the middle than at the ends. When a **fluid** flows through such a tube, the pressure decreases as the diameter becomes smaller, the amount of the decrease being proportional to the speed of **flow** and the amount of restriction.

Venus. See **planet,** table.

vernal equinox. 1. That point of intersection of the **ecliptic** and the **celestial equator,** occupied by the sun as it changes from south to north **declination,** on or about March 21. Also called *March equinox, first point of Aries.* **2.** That instant the sun reaches the point of zero declination when crossing the celestial equator from south to north.

vernier. A scale or control used for fine adjustment to obtain a more precise reading of an instrument or closer adjustment of any equipment.

vernier engine. A rocket engine of small thrust used primarily to obtain a fine adjustment in the **velocity** and **trajectory** of a **rocket vehicle** just after the thrust cutoff of the last **sustainer** engine, and used secondarily to add thrust to a booster or sustainer engine. Also called *vernier rocket.*

vernier rocket = **vernier engine.**

versus. As a function of, as *temperature versus time.*

vertex. 1. The highest point of a **trajectory** or other curve, as the vertexes of a **great circle,** the points nearest the poles. **2.** = **node,** sense **3.**

vertical circle. A **great circle** of the **celestial sphere,** through the **zenith** and **nadir.** Vertical circles are perpendicular to the horizon.

The *prime vertical circle* or *prime vertical* passes through the east and west points of the horizon. The *principal vertical circle* passes through the north and south points of the horizon and coincides with the celestial meridian.

vertical gyro. A two-degree-of-freedom **gyro** with provision for maintaining its **spin axis** vertical. In this gyro, output signals are produced by gimbal angular displacements which correspond to components of the angular displacements of the base about two orthogonal axes.

vertical scanning. See **scanning.**

vertigo. The sensation that the outer world is revolving about the patient (*objective vertigo*) or that he himself is moving in space (*subjective vertigo*).

The word frequently is used erroneously as a synonym for dizziness or giddiness to indicate an unpleasant sensation of disturbed relations to surrounding objects in space.

very high frequency (*abbr* **VHF**). See **frequency bands.**

very-high-speed motion-picture photography. Picture taking at a frequency range from 500 to 10,000 pictures per second.

very low frequency (*abbr* **VLF**). See **frequency bands.**

vestigial sideband (*abbr* **VSB**). The transmitted portion of the **sideband** which has been largely suppressed by a **transducer** having a gradual cutoff in the neighborhood of the **carrier frequency,** the other sideband being transmitted without much suppression.

VHF (*abbr*). See **frequency band.**

vibration. 1. Motion due to a continuous change in the magnitude of a given force which reverses its direction with time.

Vibration is generally interpreted as the cyclical (symmetrical or nonsymmetrical) fluctuations in the rate at which an object accelerates.

In *longitudinal vibration* the direction of motion of the particles is the same as the direction of advance of the vibratory motion; in *transverse vibration* it is perpendicular to the direction of advance.

2. The motion of an oscillating body during one complete **cycle;** two **oscillations.**

vibration isolator. A resilient support that tends to isolate a system from steady-state excitation. Also called *isolator.*

video. Pertaining to the picture signals in a television system or to the information-carrying signals which are eventually presented on the **cathode-ray tubes** of a **radar.**

videofrequency. Any **frequency** used in transmission images, as by television.

video signal = target signal.

Virgo (*abbr* **Vir, Virg**). See **constellation.**

vidicon. A television pickup tube utilizing a photoconductor as the sensing element. In conjunction with a telescope this is known as a *vidicon telescope.*

view factor. The fraction of the total energy emitted by one surface that is directly incident on another surface. Also called *geometric factor*, *configuration factor*, *shape factor.*

Vir, Virg. International Astronomical Union abbreviations for *Virgo.* See **constellation.**

virtual gravity. The force of **gravity** on an atmospheric parcel, reduced by **centrifugal force** due to the motion of the parcel relative to the earth. The virtual gravity g* is

$$g^* = g = V^2/a - 2\Omega_n V$$

where g is the magnitude of the acceleration of gravity; V is the parcel speed; a is the earth's radius; and Ω_n is the component of the earth's angular velocity vector normal to the motion of the parcel.

For reasonable atmospheric values, the correction terms are of the order of 0.01 percent of the magnitude of gravity. The identity of g^* and g is implied by the assumption of hydrostatic equilibrium.

virtual height. The apparent height of an ionized atmospheric **layer** determined from the time interval between the transmitted **signal** and the ionospheric **echo** at vertical incidence, assuming that the velocity of propagation is the velocity of light in a vacuum over the entire path. See **ionospheric recorder.** Compare **scale height.**

virtual image. An image that cannot be shown on a surface but is visible, as in a mirror.

virtual mass. The actual mass of a body, plus its **apparent additional mass.**

virtual stresses = Reynolds stresses.

viscosity. That molecular property of a **fluid** which enables it to support tangential **stresses** for a finite time and thus to resist deformation; the ratio of shear stress divided by shearing strain. See **viscosity coefficient.**

viscosity coefficient. The ratio of the shearing component of **stress** to the velocity **gradient** in a fluid where the stress acts across a plane perpendicular to the direction of the velocity gradient. Also called *viscosity.* See also **dynamic viscosity, kinematic viscosity, eddy viscosity.**

viscosity manometer = decrement gage.

viscous. Pertaining to **viscosity,** as a *viscous fluid.*

viscous damping. The dissipation of energy that occurs when a **particle** in a vibrating system is resisted by a **force** that has a magnitude proportional to the magnitude of the velocity of the particle and direction opposite to the direction of the particle.

viscous flow. The flow of **fluid** through a duct under conditions such that the **mean free path** is very small in comparison with the smallest dimension of a transverse section of the duct.

This flow may be either laminar or turbulent.

viscous fluid. A fluid whose molecular **viscosity** is sufficiently large to make the **viscous forces** a significant part of the total force field in the fluid. See **Navier-Stokes equations, viscous stresses.** Compare **inviscid fluid.**

viscous force. The force per unit volume or per unit mass arising from the action of tangential **stresses** in a moving **viscous fluid.** This force may then be introduced as a term in the **equations of motion.**

viscous stresses. The components of the **stress tensor** when the pressure, i.e., the mean of the three normal stresses, has been subtracted out from each of the normal stresses. See **Reynolds stresses.**

visibility meter. The general term for instruments used to make direct measurements of **visual range** in the **atmosphere** or of the physical characteristics of the atmosphere which determine the visual range.

Visibility meters may be classified according to the quantities that they measure. Telephotometers and transmissometers measure the **transmissivity** or alternatively, the **extinction coefficient** of the atmosphere. Nephelometers measure the **scattering function** of the atmospheric **suspensoids.** A third category of visibility meters makes use of an artificial haze of variable density which is used to obscure a marker at a fixed distance from the meter.

visible binaries. See **binary star.**

visible horizon. See **horizon.**

visible radiation. Electromagnetic radiation lying within the wavelength interval to which the human eye is sensitive, the spectral interval from approximately 0.4 to 0.7 micron (4000 to 7000 angstroms).

The term is without reference to the variable response of the human eye in its reception of radiation.

visible spectrum. That portion of the **electromagnetic spectrum** occupied by the wavelengths of **visible radiation,** roughly 4000 to 7000 angstroms. This portion of the electromagnetic spectrum is bounded on the short-wavelength end by ultraviolet radiation, and on the long-wavelength end by infrared radiation.

visual magnitude (*symbol* m_v). The **apparent magnitude** of a star or other **celestial body** measured by visual observation. See **photovisual magnitude, color index.**

visual photometer. See **photometer.**

visual photometry. A subjective approach to the problem of **photometry,** wherein the human eye is used as the sensing element; to be distinguished from **photoelectric photometry.**

visual range. The distance, under daylight conditions, at which the apparent contrast between a specified type of target and its background becomes just equal to the **threshold** contrast of an observer; to be distinguished from the **night visual range.** Also called *daytime visual range.*

vitrifying tendency. Tendency of the crystalline phase of a **ceramic** to transform into an amorphous or glassy phase when subjected to aging or temperature cycling.

VLF (*abbr*). See **frequency band.**

void fraction. The fraction of the frontal area of a **reactor** that is open to airflow. Also called *free-flow area.*

Vol, Voln. International Astronomical Union abbreviations for *Volans.* See **constellation.**

Volans (*abbr* **Vol, Voln**). See **constellation.**

Voln. International Astronomical Union abbreviation for *Volans.* See **constellation.**

volt (*abbr* **V, v**). The unit of electric potential difference and electromotive force, equal to the difference of electric potential between two points of a conductor carrying a constant current of 1 ampere when the power dissipated between these points equals 1 watt.

volume level. In an electric circuit, the **level,** as measured on a standard volume indicator, of a complex wave such as produced by speech or music. Often shortened to *volume.*

The term *volume* is also used loosely to signify the magnitude of a sound or audiofrequency wave.

volume scattering function. See **scattering function.**

volume unit. The unit of **volume level** as measured by a standard volume indicator. The volume level in volume units is the number of decibels by which the volume level exceeds the reference volume level.

VOR (*abbr*) = **VHF omnirange.**

vortex. 1. Any **flow** possessing **vorticity. 2.** Specifically a flow with closed **streamlines** or the idealized case in which all vorticity is concentrated in a **vortex filament.**

vortex filament. A line along which an infinite **vorticity** in a **fluid** motion is concentrated, the surrounding fluid being free of vorticity.

In an autobarotropic frictionless fluid, a vortex line always consists of the same fluid particles; the vortex filament is, thus, a **vortex line** and is the limiting case of a **vortex tube** as the cross-sectional area of the tube shrinks to zero.

vortex line. A curve tangent at every point of a field to the **vorticity** vector at that point.

vortex ring. A closed **vortex filament.**

vortex street. Two parallel rows of alternately placed vortexes along the wake of an obstacle in a fluid of moderate **Reynolds number.** Also called *Kármán vortex street, vortex trail, vortex train.*

Fluid drag can be calculated from the motion of these vortexes, which are stable only for a certain ratio of the width of the street to the distance between vortexes along the street.

vortex trail = **vortex street.**

vortex train = **vortex street.**

vortex tube. The closed surface or tube consisting of the **vortex lines** passing through every point of a given closed curve.

vorticity. A **vector** measure of local **rotation** in a fluid flow, defined mathematically as the curl of the velocity vector,

$$\Omega = \nabla \times V$$

where Ω is the vorticity; V is the velocity; and ∇ is the del-operator.

The vorticity component normal to a small plane element is the limit of the circulation per unit area as the area of the element approaches zero.

The vorticity of a solid rotation is twice the angular velocity vector.

In meteorology, ***the vorticity*** usually refers to the vertical component of the vorticity as defined above.

vorticity equation. A dynamic equation for the rate of change of the vorticity of a parcel, obtained by taking the curl of the vector equation of motion.

vorticity of the earth = **coriolis parameter.**

vorticity-transport hypothesis. The hypothesis that, owing to the existence of pressure fluctuations, vorticity and not momentum is conservative in turbulent eddy flux. This would apply especially if the turbulence were strictly two dimensional.

Vul, Vulp. International Astronomical Union abbreviations for *Vulpecula.* See **constellation.**

Vulpecula (*abbr* **Vul, Vulp**). See **constellation.**

W

walk-around bottle. A personal supply of oxygen for the use of crewmembers when temporarily disconnected from the craft's system.

walled plain. See **lunar crater,** note.

wander. Short for **apparent wander.**

waning moon. The moon between full and new when its visible part is decreasing. See **phases of the moon.**

warhead. Originally the part of a missile carrying the explosive, chemical, or other charge intended to damage the enemy. By extension, the term is sometimes used as synonymous with *payload* or *nose cone.*

warmup time. The time interval required for a **gyro** to reach specified performance from the instant that it is energized.

water. Dihydrogen oxide (molecular formula H_2O). The word is used ambiguously to refer to the chemical compound in general and to its liquid **phase;** when the former is meant, the term *water substance* is often used.

Water is distinguished from other common terrestrial substances in existing in all three phases at atmospheric temperatures and pressures (see **ice, water vapor**). The phase changes, with the consequent latent-heat energy changes, are of great significance in many geophysical processes. The same is true of the large specific heat of liquid water and ice relative to both land surface and atmosphere. Water's complex absorption spectrum gives rise to the **greenhouse effect.**

waterfall effect = **Lenard effect.**

water-flow pyrheliometer. An absolute **pyrheliometer,** developed by C. G. Abbot, in which the radiation-sensing element is a blackened water **calorimeter.**

It consists of a cylinder blackened on the interior and surrounded by a special chamber through which water flows at a constant rate. The temperatures of the incoming and outgoing water, which are monitored continuously by thermometers, are used to compute the intensity of the radiation. This instrument is used by the Smithsonian Institution as its standard instrument.

water substance. See **water.**

water suit. A **g-suit** in which the fluid used in the interlining is a liquid, thereby automatically approximating the required hydrostatic pressure gradient under acceleration.

water vapor. Water (H_2O) in gaseous form. Also called *aqueous vapor.* See **vapor.**

The amount of water vapor present in a given gas sample may be expressed in a number of ways. See **absolute humidity, mixing ratio, dewpoint, relative humidity, specific humidity, vapor pressure.**

water-vapor absorption. The absorption of certain wavelengths of **infrared radiation** by atmospheric **water vapor.** See **absorption band.**

The water-vapor absorption spectrum is composed of bands near 1.4, 1.8., 2.7, and 6.3 microns and a series of bands beginning at 11 microns and growing stronger with increasing wavelength.

watt (*abbr* **w, W**). The unit of power in the **MKSA system;** that power which produces energy at the rate of 1 **joule** per second.

wave. A disturbance which is propagated in a medium in such a manner that at any point in the medium the **quantity** serving as measure of disturbance is a function of the time, while at any instant the **displacement** at a point is a function of the position of the point.

Any physical quantity that has the same relationship to some independent variable (usually time) that a propagated disturbance has, at a particular instant, with respect to space, may be called a *wave.*

wave equation. The partial differential equation of the form

$$\nabla^2\varphi = (1/C^2)\ (\partial^2\varphi/\partial t^2)$$

where φ is usually a function of the position and time coordinates; ∇^2 is the Laplacian operator; t is the time; and C^2 is a constant. Also called *equation of wave motion.* See **wave, gravity wave.**

The general solution to this equation is any function defined over a plane, the phase front, moving perpendicular to itself at the speed c.

wave filter. A **transducer** for separating **waves** on the basis of their **frequency.** It introduces relatively small loss to waves in one or more frequency bands and relatively large loss to waves of other frequencies. Also called *filter.*

waveform. The graphical representation of a **wave,** showing variation of **amplitude** with time.

wave front = **phase front.**

waveguide. A system of boundaries capable of guiding waves.

wave interference. The phenomenon which results when **waves** of the same or nearly the same **frequency** are superposed; characterized by a spatial or temporal distribution of **ampli-**

tude of some specified characteristic differing from that of the individual superposed waves. Also called *interference.*

wavelength (*symbol* λ). In general, the mean distance between maximums (or minimums) of a roughly **periodic** pattern. Specifically, the least distance between particles moving in the same **phase** of **oscillation** in a **wave** disturbance.

The wavelength is measured along the direction of propagation of the wave, usually from the midpoint of a crest (or trough) to the midpoint of the next adjoining crest (or trough). It is related to frequency f and phase speed ν by

$$\lambda = \nu/f$$

where λ is wavelength. The reciprocal of wavelength is the **wave number.**

wavelets. See **Huygen wavelets.**

wave motion. The oscillatory motion of the particles of a medium caused by the passage of a **wave,** produced by forces external to the medium, but propagated through the medium by internal forces. Wave motion per se involves no net translation of the medium.

Various types of **oscillation** are found in natural wave motions. Among the simplest are the linear oscillation parallel to the direction of propagation of a longitudinal wave, the linear oscillation perpendicular to the direction of propagation of a transverse wave, and the orbital motion produced by the passage of a progressive gravity wave.

wave number (*symbol* $\bar{\nu}$). The reciprocal of **wavelength;** the number of waves per unit distance in the direction of **propagation;** or, sometimes 2π times this quantity.

In spectroscopy, wave number is usually expressed in reciprocal centimeters, as 100,000 cm^{-1} (100,000 per centimeter).

wave of translation. A **wave** in which the individual particles of the medium are shifted in the direction of wave travel, as ocean waves in shoal waters; in contrast with an **oscillatory wave,** in which only the form advances, the individual particles moving in closed orbits, as ocean waves in deep water.

wave speed = **phase velocity.**

wave theory of light. See **electromagnetic radiation.**

wave train. A limited series of **waves** caused by a periodic disturbance of short duration, e.g., the radiofrequency waves in a single pulse, or a succession of pulses themselves.

wave velocity = **phase velocity.**

web. The wall of a grain or propellant with an internal cavity.

weber (*abbr* **wb**). The unit of **magnetic flux;** the magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of 1 **volt** as it is reduced to zero at a uniform rate in 1 second.

Weber-Fechner law. An approximate psychophysical law relating the degree of response or sensation of a sense organ and the intensity of the **stimulus.** The law asserts that equal increments of sensation are associated with equal increments of the logarithm of the stimulus, or that the just noticeable difference in any sensation results from a change in the stimulus which bears a constant ratio to the value of the stimulus. Also called *Weber law.*

The Weber-Fechner law is applied to the detection of contrast in the problem of visual range, as well as to many other psychophysical problems.

Weber law = **Weber-Fechner law.**

weight (*symbol* w). **1.** The **force** with which a body is attracted toward the earth. **2.** The product of the **mass** of a body and the **acceleration** acting on a body.

In a dynamic situation, the weight can be a multiple of that under resting conditions. Weight also varies on other planets in accordance with their gravity.

weight flow rate (*symbol* $\dot{w}$). Mass flow rate multiplied by gravity, or

$$\dot{w} = (dm/dt)g = mg$$

Where m is mass and t is time; usually expressed in pounds per second.

weightlessness. 1. A condition in which no acceleration, whether of **gravity** or other force, can be detected by an observer within the **system** in question.

Any object falling freely in a vacuum is weightless, thus an unaccelerated satellite orbiting the earth is *weightless* although gravity affects its orbit. Weightlessness can be produced within the atmosphere in aircraft flying a parabolic flightpath.

2. A condition in which gravitational and other external forces acting on a body produce no stress, either internal or external, in the body.

welding. Joining two or more pieces of metal by applying heat, pressure, or both, with or without filler material to produce a localized union through fusion or recrystallization across the interface.

The thickness of the filler material is much greater than the capillary dimensions encountered in **brazing.**

wet. To come in contact with, and flow across (a surface, body, or area)—said of air or other **fluid.**

wet emplacement. A **launch emplacement** that provides a deluge of water for cooling the **flame bucket,** the **rocket engines,** and other equipment during the launch of a missile. See **flame deflector, dry emplacement.**

wet-fuel rocket = **liquid rocket.**

whistler. A **radiofrequency** electromagnetic

signal generated by some lightning discharges.

This signal apparently propagates along a geomagnetic line of force and often *bounces* several times between the Northern and Southern Hemispheres. Its name derives from the sound heard on radio receivers.

whistling meteor. Name applied to a **radio meteor** when a detection system is used in which the presence of the meteor is indicated by a rapidly changing **audiofrequency** radio signal.

The maximum reflection of a radio signal from a radio meteor occurs when the ion column is perpendicular to the line from the column to the transmitter-receiver. During the approach of the meteor to this position, the Doppler effect causes a change in the frequency of the reflected signal. When the reflected signal frequency is then combined with the transmitter frequency, the difference between the transmitted and reflected frequencies produces an audiofrequency beat. The audiofrequency beat, when amplified and fed to a loudspeaker, allows the meteors to be *heard* as a high-pitched whistle which rapidly falls to zero frequency as the meteor trail becomes normal to the line of sight.

white body. A hypothetical body whose surface absorbs no **electromagnetic radiation** of any wavelength, i.e., one which exhibits zero **absorptivity** for all wavelengths; an idealization exactly opposite to that of the black body. See **gray body.**

In nature, no true white bodies are known. Most white pigments possessing high reflectivity for visible radiation are fairly good absorbers in the infrared; hence, they are not *white bodies* in the sense of the radiation theory. However, the term *white body* is used for physical objects with respect to a particular wavelength interval.

white noise. A **sound** or **electromagnetic wave** whose spectrum is continuous and uniform as a function of frequency.

white room. A clean and dust-free room used for assembly and repair of precise mechanisms such as gyros.

Wien displacement constant. See **Wien law.**

Wien displacement law = Wien law.

Wien distribution law. A relation, derived on purely **thermodynamic** reasoning by Wien, between the monochromatic **emittance** of an ideal **black body** and that body's **temperature.**

$$J_\lambda/T^5 = f(\lambda, T)$$

where J_λ is the monochromatic **emittance** (emissive power) of a black body at wavelength λ and absolute temperature T, and $f(\lambda, T)$ is a function which cannot be determined purely on classical thermodynamic grounds. Compare **Wien law.**

Wien law. One of the **radiation laws** which states that the wavelength of maximum radiation **intensity** for a **black body** is inversely proportional to the **absolute temperature** of the radiating black body:

$$\lambda_m = b/T$$

where λ_m is the wavelength of maximum intensity; b is a constant; and T is the absolute temperature. The Wien displacement constant b is equal to 0.28978 centimeter-degree. Also called *Wien displacement law.*

This law, established experimentally by Wien in 1896, describes the manner in which the wavelength of maximum radiation shifts toward shorter values as the temperature of a radiator rises. It is to be distinguished from **Wien distribution law** which describes the variation with temperature of the intensity of emission at any wavelength. Wien displacement law is used to compute the color temperature of a radiator by insertion of its wavelength of peak intensity into the above equation to compute T.

wind axis. Any one of a system of mutually perpendicular reference axes established with respect to the undisturbed wind direction about an aircraft or similar body. See **axis,** sense **2.**

window. 1. Any device introduced into the atmosphere for producing an appreciable radar **echo,** usually for tracking some airborne device or as a tracer of wind. **2.** A World War II code name for a type of **radar**-jamming device employed to confuse the operators of enemy radars (also referred to by the code names of *rope*, *chaff*, and *clutter*).

One type of window consists of packages containing thousands of small strips of paperbacked tinfoil which may be dropped from aircraft and balloons, ejected from rockets, and carried within balloons. The packages burst open upon ejection, scattering the tinfoil widely, producing a radar echo which looks like a small shower or a tight formation of aircraft on plan-position-indicator scopes.

3. Any gap in a linear **continuum,** as *atmospheric windows*, ranges of wavelengths in the electromagnetic spectrum to which the atmosphere is transparent, or *firing windows*, intervals of time during which conditions are favorable for launching a spacecraft on a specific mission.

wind shear. See **barotropic model.**

wind tunnel. A tubelike structure or passage, sometimes continuous, together with its adjuncts, in which a high-speed movement of air or other gas is produced, as by a fan, and within which objects such as engines or aircraft, airfoils, rockets (or models of these objects), etc., are placed to investigate the **airflow** about them and the **aerodynamic forces** acting upon them.

Tunnels are designated by the means used to produce the gas flow, as *hot shot tunnel, arc tunnel, blow down tunnel*; by the speed range, as *supersonic tunnel, hypersonic tunnel*; or by the medium used, as *plasma tunnel, light gas tunnel.*

wind-tunnel balance. A device or apparatus that measures the **aerodynamic forces** and

moments acting upon a body tested in a **wind tunnel.**

winter solstice. **1.** That point on the **ecliptic** occupied by the sun at maximum southerly **declination.** Sometimes called *December solstice, first point of Capricornus.* **2.** That instant at which the sun reaches the point of maximum southerly declination, about December 22.

wireless. Sometimes used as the equivalent of **radio,** particularly in British terminology.

wire link telemetry. **Telemetry** in which no **radio** link is used. Also called *hard wire telemetry.*

Wolf number = relative sunspot number.

Wolf-Wolfer-Wolfest number = relative sunspot number.

word. In electronic computers, an ordered set of **characters** which is the normal unit in which **information** may be stored, transmitted, or operated upon within a **computer.**

word rate. In **computer** operations, the **frequency** derived from the elapsed period between the beginning of transmission of one **word** and the beginning of transmission of the next word.

work (*symbol W*). **Energy** resulting from the motion of a system against a **force** and existing only during the process of energy conversion.

work function. The **energy** required for an **electron** to escape a solid surface. See **Helmholtz function.**

In ion engines, the work function of the ionizer must be greater than the **ionization potential** of the neutral atoms in the propellant gas.

working fluid. A **fluid** (gas or liquid) used as the medium for the transfer of **energy** from one part of a **system** to another part.

World Geographic Reference System. A geographic reference system for the world, used in the Air Force for aircraft position reports and target designation, and for the control and direction of air units engaged in air defense, air-sea rescue, and tactical air operations.

The short title for this system is *georef.*

write. In computer terminology, record.

X

X-band. A **frequency band** used in **radar** extending approximately from 5.2 to 10.9 kilomegacycles per second.

X-ray. Nonnuclear electromagnetic radiation of very short **wavelength,** lying within the interval of 0.1 to 100 angstroms (between gamma rays and ultraviolet radiation). Also called *X-radiation, Roentgen ray.*

X-rays penetrate various thicknesses of all solids and they act upon photographic plates in the same manner as light. Secondary X-rays are produced whenever X-rays are absorbed by a substance; in the case of absorption by a gas, this results in ionization.

X-radiation = X-ray.

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Y

yagi antenna. A type of **directional antenna** used on some types of radar and radio equipment consisting of an **array** of elemental, single-wire **dipole** antennas and reflectors.

yard (International). Exactly 0.9144 **meter.**

The U.S. yard before 1 July 1959 was 0.91440183 meter.

yaw. **1.** The rotational or oscillatory movement of an aircraft, rocket, or the like about a vertical axis. **2.** The amount of this movement, i.e., the angle of yaw. **3.** To cause to **rotate** about a vertical axis. **4.** To **rotate** or **oscillate** about a vertical axis.

yaw angle = angle of yaw.

yaw axis. A vertical **axis** through an aircraft, rocket, or similar body, about which the body **yaws.** It may be a body, wind, or stability axis. Also called a *yawing axis.*

yawing axis = yaw axis.

yawing moment. A **moment** that tends to **rotate** an aircraft, an airfoil, a rocket, etc., about a vertical **axis.**

This moment is considered positive when it rotates clockwise.

year. A period of one revolution of the earth around the sun.

The period of one revolution with respect to the vernal equinox, averaging 365 days 5 hours 48 minutes 45.68 seconds in 1955, is called a *tropical, astronomical, equinoctial, natural,* or *solar* year. The period with respect to the stars, averaging 365 days 6 hours 9 minutes 9.55 seconds in 1955, is called a *sidereal* year. The period of revolution from perihelion to perihelion, averaging 365 days 6 hours 13 minutes 53.16 seconds in 1955, is an *anomalistic year.* The period between successive returns of the sun to a sidereal hour angle of 80° is called a *fictitious* or *Besselian* year. A *civil year* is the calendar year of 365 days in common years, or 366 days in leap years. A *light year* is a unit of length equal to the distance light travels in one year, 9.460×10^{12} kilometers. The term *year* is occasionally applied to other intervals such as an *eclipse year,* the interval between two successive conjunctions of the sun with the same node of the moon's orbit, a period averaging 346 days 14 hours 52 minutes 52.23 seconds in 1955, or a *great* or *Platonic year,* the period of one complete cycle of the equinoxes around the ecliptic, about 25,800 years.

Young modulus (*symbol E*). The ratio of normal **stress** within the proportional limit to the corresponding normal **strain.**

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Z

zenith. That point of the **celestial sphere** vertically overhead.

The point 180° from the zenith is called the *nadir.*

zenithal. Of or pertaining to the **zenith.**

zenith attraction. The effect of the earth's gravity on a **meteoric** body, which increases the velocity and moves the **radiant** toward the **zenith.**

zenith distance. Angular distance from the **zenith;** the arc of a **vertical circle** between the zenith and a point on the **celestial sphere,** measured from the zenith through 90°, for bodies above the horizon.

This is the same as coaltitude with reference to the celestial horizon.

zenographic. Referring to positions on Jupiter measured in **latitude** from Jupiter's equator and in **longitude** from a reference meridian.

zero gravity = weightlessness.

zero-g = weightlessness.

zero launch. The launch of a rocket or aircraft by a **zero-length launcher.**

zero launcher. A **zero-length launcher.**

zero-length launcher. A **launcher** that holds a vehicle in position and releases the rocket simultaneously at two points so that the buildup of **thrust,** normally rocket thrust, is sufficient to take the missile or vehicle directly into the air without need of a take-off run and without imposing a pitch rate release.

The term is not normally applied to a pad used for a vertical launch.

zero-length rocket. A **rocket** with a sufficient thrust to launch a vehicle directly into the air.

Said especially of a rocket used to launch an aerodynamic vehicle.

zero-lift chord. A **chord** taken through the trailing edge of an **airfoil** in the direction of the relative wind when the airfoil is at a zero-lift angle of attack.

zeta machine. An experimental **thermonuclear device** which generates a **plasma** inside a torus and employs the **pinch effect** for heating and compression.

zip fuel. A boron-base high-energy **liquid propellant.**

zodiac. The band of the sky extending 8° either side of the **ecliptic.**

The Sun, Moon, and navigational planets are always within this band, with the occasional exception of Venus. The zodiac is divided into 12 equal parts, called *signs,* each part being named for the principal constellation originally within it.

zodiacal counterglow = gegenschein.

zodiacal light. A faint cone of light extending upward from the horizon in the direction of the **ecliptic** (zodiac). It is seen from tropical latitudes for a few hours after sunset or before sunrise.

The spectrum of the zodiacal light is similar to that of sunlight, so it has been suggested that it is due to the scattering of sunlight by extraterrestrial dust particles. Some scattering is also due to electrons.

zone time. See **time.**

z-time = Greenwich mean time.

Zurich number = relative sunspot number

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